Engineering ERAL LIBRARY

IN TWO SECTIONS—SECTION ONE

JUL 21 1919
OF MICH

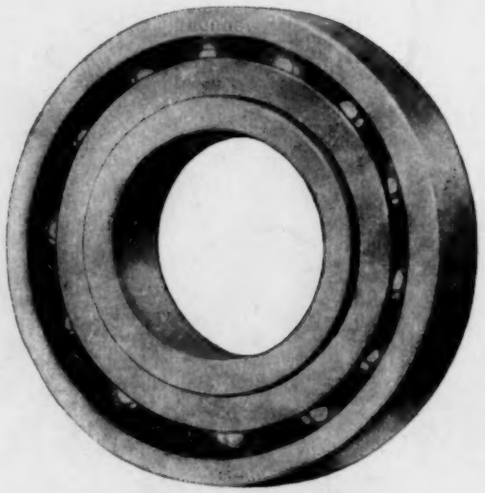
MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

JULY ~ 1919

PUBLISHED MONTHLY BY THE SOCIETY
29 WEST 39TH STREET, NEW YORK, U.S.A.

Pioneering



When you buy Gurney Ball Bearings you get, not an experiment, but a product of proven worth.

Back of the name GURNEY are fourteen years of study, experiment, tryout, of patient and intelligent development of design, material, and processes.

When you submit your bearing problems to the Gurney Service Engineering Department, you reap the reward of our pioneering. You get a finished product, of KNOWN capacity, efficiency, and durability.

F. W. Gurney.

GURNEY

GURNEY BALL BEARING CO.

Conrad Patent Licensee

JAMESTOWN, N. Y.

358

GURNEY

Volume 41 Number 7

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

JULY, 1919

SECTION ONE	PAGE
Spring Meeting of the A.S.M.E.	567
Discussion of Industrial Relations	572
Industrial Personnel Relations, A. H. Young.	581
Condition of Research in the United States, A. M. Greene, Jr.	587
Research Work on Malleable Iron, E. Touceda.	593
Discussion of the Report of the Committee on Aims and Organization	601
Crude-Oil Motors vs. Steam Engines in Marine Practice, J. W. Morton	609
Correspondence	613
Work of the Boiler Code Committee	614
ENGINEERING SURVEY	615
A Review of the Engineering Periodicals.	
The Still Engine	627
Editorial Notes	628
Division of Engineering of the National Research Council	631
Engineering Council	632
News of the Engineering Societies	635
Professional Reorganization of the American Engineering Standards Committee	638
Award of John Fritz Medal to Major-General Goethals	639
Necrology	640
Personals	642
Library Notes and Book Reviews	643
THE ENGINEERING INDEX	1*a*

ADVERTISING SECTION

Display Advertisements	2*b*
Consulting Engineers	88
Engineering Colleges	92
Classified List of Mechanical Equipment	94
Members' Exchange	111
Alphabetical List of Advertisers	112

SECTION TWO—SOCIETY AFFAIRS

The Secretary's Letter	ii
Council Notes	iii
Lesson from England	iv
Meetings of Sections	v
Meetings of Student Branches	v
Employment Bulletin	vi
Candidates for Membership	xi

PUBLISHED MONTHLY BY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West Thirty-ninth Street, New York

PRICE 35 CENTS A COPY, $3.00 A YEAR; TO MEMBERS AND AFFILIATES, 25 CENTS A COPY, $2.00 A YEAR. POSTAGE TO CANADA, 50 CENTS ADDITIONAL; TO FOREIGN COUNTRIES, $1.00 ADDITIONAL

C. 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Entered as second-class matter, January 4, 1912, at the Post Office, New York, N. Y., under the act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 8, 1918.

Prepare for the Annual Meeting!

The Detroit Meeting of The American Society of Mechanical Engineers had the largest attendance of members and guests of any Spring Meeting which the Society has held. The active interest shown in the work of the engineer, in his profession and public relations, and in the possibilities for the development of the A.S.M.E. and the expansion of its publications, exceeded by far that of any other convention of the Society. The discussion on Aims and Organization extended over a period of three days and the interest in the technical sessions was fully sustained up to the closing hour of the last day.

The Committee on Meetings and Program is now directing its attention to the arrangements for the Annual Meeting to be held in New York during the first week in December. It is believed that like the Detroit meeting just held, in its relation to previous Spring Meetings, the coming Annual Meeting will exceed in interest and value all previous Annual Meetings.

The Committee on Meetings and Program desires the coöperation of the membership in its efforts to make this a record meeting of the Society. Suggestions are desired for papers, subjects for discussion, and of authors who might contribute.

The engineers of the country are awake to their opportunities. They are not only considering "engineering problems" in the older sense, but also "problems for engineers." Suggestions, therefore, which are broad in scope and varied in kind will be welcome.

Above all, those who contemplate preparing papers are requested to advise the Secretary at once and are urged to complete their manuscripts not later than October first. The early delivery of papers will greatly facilitate the work of preparation for the meeting and will avoid disappointment on the part of authors through having papers held over because of lack of room on the program.

Spring Meeting of the A. S. M. E.

This Meeting, Held at Detroit, June 16-19, Was Featured by a Large Attendance, Extended Discussion on Aims and Organization, and Sessions on Research, Industrial Relations and Pulverized Fuel. Many Entertainment Features

WERE it not that the phrase is devoid of any idea of superlatives, the expression "a well-balanced meeting" would correctly characterize the Detroit meeting of The American Society of Mechanical Engineers, held June 16 to 19. The meeting was remarkably well balanced, both in respect to variety of subjects discussed and in the relation which these features bore to the entertainment provided by Detroit's hospitable citizens. It was, however, also a meeting of big things and peak loads. Whenever a high point was registered in one direction, it was immediately followed by an event of corresponding magnitude in some other direction, and so throughout the four days of the meeting there was a rapid succession of occurrences of the greatest interest.

The meeting started on high gear, full speed, on the very first day, over 250 arrivals having been registered on Sunday night and many more the next morning for the Business Meeting which was held on Monday afternoon. Somewhere in the impelling force there was a "hot spot" (this does not refer to the weather, although it might properly do so), which kept up a rapid acceleration of events and produced smooth running throughout the whole period. Every indication pointed to this as being located in the vicinity of the City Hall.

The total registration was 1180, the largest of any Spring Meeting, of which 638 were members and 542 were guests. In 1895, when the Society first met in Detroit, the registration was 132; and again in 1908, 265. This is indicative both of the growth of the Society and the interest of its membership, and of the growth and popularity of Detroit itself, which one of the soldiers returning from France has said he found, when in Europe, to be "the most-talked-of American city." It was obviously a city that the members of the Society desired to visit, and to say that all left immeasurably pleased with the opportunities afforded them for pleasure or profit is but to summarize the sentiments freely expressed by those in attendance.

Features of the Meeting

The dominating feature of the meeting was the discussion of the Report of the Aims and Organization Committee summarized in this number. This began on Monday afternoon and continued on Tuesday and Wednesday. It was a new thing in the annals of an engineering society to have so many members eager to discuss the professional work and opportunities of the Society itself and for its members in general in relation to their profession and the public at large.

Three of the professional sessions also drew large audiences, one of these, the opening session, being on the subject of Research and lasting all day. This again shows the awakening interest of engineers in conditions resulting from the war and an appreciation by them of the need for research work in the development of American industries. A session on Industrial Relations, in which the human side of industrial management was developed, evoked so much enthusiasm that a resolution was passed at its conclusion calling for a continuance of the discussion at the Annual Meeting. On Thursday morning, at the conclusion of the meeting, one of the largest audiences gathered for a discussion on pulverized fuel, although several important excursions, which also were largely attended, were scheduled at the same hour.

Headquarters of The American Society of Mechanical Engineers, Detroit Meeting, June 16-19, 1919

Business Meeting

Unlike previous years, the business meeting was held on the opening day, occurring this year on Monday afternoon. Pres. Mortimer E. Cooley presided, and, after expressing his pleasure at the choice of Detroit as a meeting place, called for the report of the tellers of election. This report, which was presented by Secretary Calvin W. Rice, embodied the following amendment to the constitution:

C48 There shall be a Nominating Committee, whose duty shall be to select candidates for the elective offices to be filled at each election. This Committee shall be elected annually by the voting membership of the Society. Other Nominating Committees having the same powers may be constituted by the voting membership. The number of members, the selection, organization and procedure of all Nominating Committees shall be as the By-Laws shall provide.

This amendment had already been voted upon by the membership, and the chairman accordingly declared it to be a law of the Society.

The report of the Boiler Code Committee was next presented by John A. Stevens, Chairman. This report, which was presented by title only, is a preliminary one covering the rules for the construction of boilers of locomotives which are not subject to Federal inspection and control. It is intended to form Section III of Part I of the present well-known Boiler Code, and was accepted without any discussion.

Progress reports were then presented by the Sub-Committee on Bearing Metals, and the Sub-Committee on Lubrication. These were also presented by title only, as they were available in printed form and had been accepted by the Council. C. H. Bierbaum is chairman of the Sub-Committee on Bearing Metals and Albert Kingsbury chairman of the Sub-Committee on Lubrication.

The meeting next proceeded with what the chairman characterized as "perhaps the most important business this Society has had for consideration in many years." This was the report of the Committee on Aims and Organization, of which Louis C. Marburg is chairman.

Before presenting his report, Mr. Marburg called attention to the fact that a joint committee of the four national engineering societies on Aims and Organization had been created, and that a meeting of this committee was to be held in New York on July 2. "The coöperation among the various committees of development is very close," said Mr. Marburg. "We are in continual contact, and it is remarkable how closely the lines of thinking in the different development committees agree."

Address by Frazer S. Keith, Secretary of the Engineering Institute of Canada

Preceding the discussion of the report of the Aims and Organization Committee, the Society had the pleasure of listening to Frazer S. Keith, who together with Mr. John A. Brown and Mr. Riddell were delegated by the Engineering Institute of Canada to attend the convention. Mr. Keith first conveyed the personal regrets of Sir Alexander Bertram and Mr. H. H. Bond, two prominent mechanical engineers of Canada and members of the Canadian Institute, at their inability to accept an invitation to be present, and then spoke of the work of the professional engineering society.

Mr. Keith voiced his belief in the adoption of activities whereby there will be aroused a fervent sense of loyalty on the part of every man who is a member of the profession. "Loyalty," he said, "combined with enthusiasm, is a prime necessity to any cause, and before the engineering profession can become a powerful national organization, its members must be intensely loyal to the profession itself. To the average engineer the national society of which he is a member embodies all that the profession represents to him. Whatever may be the aims and objects of that society, such constitute the engineering profession. If their aims be narrow, likewise will their viewpoint be circumscribed. Now, to create that loyalty there seems to be one sure method, that is, the loyalty combined with an intense professional spirit, which we must all admit, is required, and to accomplish that the promotion of the personal welfare of the members to a greater extent than has been customary in the past, seems to be necessary. When mention is made of one of these methods, that is, assisting to raise the salaries of the rank and file of the engineering profession, by means of adopting a schedule, we immediately hear the cry "Trade Unionism," but it is nothing of the sort.

In Canada we have broadened our vision. We have become cognizant of the fact and have taken it on ourselves to recognize that we have a definite responsibility to the individual member in assisting him in his material welfare, and this, combined with the fact that one of our objects is to enhance the usefulness of the profession to the public, is arousing a professional consciousness and a sense of loyalty greater than ever existed before. It is believed that in direct proportion to the attention which we have given to the material welfare of the members and the endeavor to make the profession useful to the public has loyalty to, and interest in, the profession increased. And, further, as the interest in the profession has increased, so has the influence of the profession developed.

There is another subject which is quite prominent in all engineering bodies. I refer to the question of capital and labor. This is the greatest problem confronting this continent today. Capital cannot solve this problem, and labor cannot solve it, because each is biased. The lawyer cannot solve this problem because his mind is not sufficiently instructed; and the politician cannot solve it because he lacks prospective. To whom, then, must we look for the solution? The mind that can design and construct and place in operation a Panama Canal, a battleship, a big bridge, a power plant, or a modern industrial organization; the mind that goes back to first principles in the solution of any problem—this, gentlemen, is the mind that must be brought to bear upon this important problem, and I believe that here lies one of the greatest opportunities which the engineering profession has ever had presented to it.

Research Session

A session in which deep interest was exhibited due to a realization of the pressing need for advancing the work with which it dealt, was that planned for the morning of Tuesday, June 17, by the Research Committee of the Society, but to which it was found necessary to devote the entire day. Four papers and an address dealing with various phases of the subject were presented: namely, The Present Condition of Research in the United States, by Arthur M. Greene, Jr., Chairman of the Research Committee and who also presided; The Organization and Conduct of an Industrial Laboratory, by A. D. Little and H. E. Howe, of Cambridge, Mass.; Organization and Conduct of a Research Laboratory, by Dr. C. K. Mees, of the Eastman Kodak Co., Rochester, N. Y.; Research Work on Malleable Iron, by Enrique Touceda, of Troy, N. Y.; and an address by Dr. G. H. Clevenger, acting chairman of the National Research Council, on its work in organizing the research activities of the country and especially on the work of its Engineering Division.

In the discussion, which occupied the greater part of the afternoon, H. S. Coleman gave particulars of the organization and work of the Mellon Institute of Industrial Research at Pittsburgh, Dean John R. Allen, director of the research laboratory of the Heating and Ventilating Engineers, outlined briefly its proposed activities, Dr. Z. A. Y. Jeffers dealt with the industrial research work of the Aluminum Castings Co., and Deans Richards, Benjamin and Potter spoke regarding research work carried on at the various state engineering experiment stations. J. R. Bibbins presented a resolution proposed by the Chicago Committee which declared it to be the sense of the meeting that Engineering Council be encouraged to undertake active support of a comprehensive plan and organization of scientific and industrial research, one feature of which calls for the passage of an act and the voting of an appropriation by the present Congress. This resolution, after extended discussion, was carried.

The papers by Professor Greene and Mr. Touceda are published in this issue of MECHANICAL ENGINEERING. The others

will appear in the August issue, together with a more extended report of the discussion.

SESSION ON INDUSTRIAL RELATIONS

On Tuesday afternoon there was a very full discussion of certain phases of labor problems which are confronting manufacturers at the present time. The basic paper of the meeting was a report prepared by L. P. Alford on The Status of Industrial Relations, which gave a historical summary of the progressive stages in the development of industrial relations since the period immediately following the Civil War, with emphasis on the new aspects of the question which have arisen as a result of the economic disturbance that has followed the recent world war.

The meeting was opened by an address by Arthur H. Young, Director of the Industrial Relations Department of the International Harvester Company of Chicago, in which he described the successful experience of his company with a shop council whereby the employees participate in certain phases of the management with which they are most concerned. Mr. Young's strong personality and appealing presentation deeply impressed the large audience, and the address opened the way for a strong discussion by several members who gave excellent talks on the topics in which they were particularly interested. The first discussion was by Dr. Otto P. Geier, Director of the Service Department of the Cincinnati Milling Machine Company, who gave a very acceptable address at the Spring Meeting at Cincinnati two years ago on the work of the physician among the employees of a company.

The full report of the Industrial Relations Session is given in this number of MECHANICAL ENGINEERING.

SECTIONS SESSION

In accordance with the policy of the Meetings and Program Committee to secure papers characteristic of the engineering work done in the part of the country where the meeting is held, a Sections Session was arranged for Wednesday morning with papers contributed by the Society's sections of the Mid-West.

D. Robert Yarnall, Chairman of the Sections Committee, presided, and the first paper was J. H. Walker, of Detroit, on Central-Station Heating in Detroit. This was followed by a paper on The Production of Liberty Motor Parts at the Ford Plant, by W. F. Verner, also of Detroit. Mr. Verner's paper was illustrated with lantern slides, and these clearly showed the method of manufacturing Liberty motor cylinders and connecting-rod bearings.

The third paper on the program was Fire Engines and the Essentials of Fire Fighting, by Charles H. Fox, of Cincinnati, Ohio. Mr. Fox was unable to be present and his paper was read by the Secretary.

J. M. Spitzglass, of Chicago, presented the final paper on An Electric Device for Measuring the Flow of Fluids in Pipes, which called forth a considerable amount of discussion. There has always been widespread interest in papers on the measurement of the flow of fluids, on which the Society has had numerous contributions, as evidence of which a member—a paper-mill engineer—drove 300 miles to attend this meeting in order to secure the latest data on fluid flow which might be applicable in paper-mill work.

WHERE THEY CAME FROM

The registration of 1,180 guests and members at the Detroit meeting of The American Society of Mechanical Engineers was the largest at any Spring Meeting in the history of the Society. The registrations at the meetings in Cincinnati and Worcester, which were the largest previous meetings, were 863 and 986 respectively. The representative character of the Detroit meeting, at which there were members or guests present from 29 states and the District of Columbia, besides from Canada and Sweden, is shown by the following summary of the number in attendance from the various states and countries.

	Members	Guests
Alabama	2	1
California	4	...
Connecticut	14	5
Delaware	6	3
District of Columbia	4	1
Georgia	2	1
Illinois	50	22
Indiana	15	16
Iowa	1	...
Kansas	1	...
Louisiana	2	1
Maine	1	1
Maryland	7	4
Massachusetts	38	17
Michigan	184	252
Minnesota	5	...
Missouri	7	4
New Jersey	17	4
New York	119	55
North Dakota	1	...
Ohio	83	82
Oklahoma	1	...
Oregon	1	...
Pennsylvania	45	25
Rhode Island	5	5
Texas	1	2
Utah	1	1
Vermont	5	5
Virginia	1	...
Wisconsin	7	5
Canada	8	14
Sweden	...	3
No Address Given	...	13
	638	542

GAS POWER SESSION

The Gas Power Session was held on Wednesday morning with Prof. W. T. Magruder, Chairman of the Sub-Committee on Gas Power, presiding. Three papers were presented, the first being one by J. W. Morton, of Philadelphia, Pa., on Crude-Oil Motors vs. Steam Engines in Marine Practice, which, in the absence of the author, was outlined by F. E. Cardullo.

The second paper, A Suggested Formula for Rating Kerosene Engines, by D. L. Arnold, of Chicago, was presented by title only, but it nevertheless furnished a topic for considerable discussion. Some took exception to Mr. Arnold's suggestion, but others were of the opinion that sooner or later a formula must be adopted which will be intelligible to the average man who is unfamiliar with machinery and mechanics.

The third and last paper of the session, Standards of Carburetor Performance, was presented by its author, Prof. O. C. Berry, of Purdue University. The discussion which followed was concerned chiefly with methods of testing and actual operating conditions. Abstracts of these papers will appear later in MECHANICAL ENGINEERING, together with a fuller report of the discussions.

FUEL SESSION

The Fuel Session, which was held on Thursday morning, was practically devoted to a consideration of pulverized coal as a fuel, as two of the three papers presented dealt with that subject. John A. Stevens, a Vice-President of the Society, presided at the meeting. The first paper, Pulverized Coal as a Fuel, was contributed by N. C. Harrison, of Atlanta, Ga. and the second, Pulverized Coal for Stationary Boilers, by F. A. Scheffler and H. G. Barnhurst, both of the Fuller Engineering Company of Allentown, Pa. Mr. Harrison had made an investigation of the pulverized-fuel problem in different parts of the country for his company, the Atlantic Steel Company, and his paper constituted his report to his company.

The latter paper was accompanied by a series of lantern slides showing the different-sized meshes used to screen the fuel, the crushers, magnetic separators, washers, dryers, feeders, etc., and

installations of pulverized-fuel equipment used in connection with boilers of various sizes and designs.

The subject of pulverized coal is unquestionably a timely one and the fourteen men who took part in the discussion which followed the presentation of the two papers made evident the fact that this type of fuel is rapidly becoming more generally adopted in metallurgical work and to a considerable extent in power plants and locomotives, although it has not as yet been proved to be the solution of the many problems arising as a result of a steady decrease in the quality of fuel available. Much of the discussion was naturally of a technical nature and related particularly to the papers presented; and since these will be published later in MECHANICAL ENGINEERING, further reference to the discussion will be deferred until that time.

The session closed with the presentation by title only of C. R. Weymouth's paper on Economy of Certain Arizona Steam-Electric Power Plants Using Oil Fuel. This paper appeared in abstract form in the June issue (p. 523).

GENERAL SESSION

The General Session was held on Thursday morning, with President Cooley in the chair. Five papers were presented, two, however, by title only. Professor Alphonse A. Adler, of Brooklyn, N. Y., presented the first of these, on The Design of Riveted Butt Joints, and Lieut. J. F. Robbins, U. S. N. R. F., the second, on Mechanical Lifts, Past and Present, and A New Method for Their Balancing.

Walter C. Durfee, of Boston, Mass., next presented his paper on Elements of a General Theory of Airplane-Wing Design, and following the discussion of these three papers the chairman announced the titles of the other two: Air Fans for Driving Electric Generators on Airplanes, by Capt. G. Francis Gray, U. S. A.; Lieut. John W. Reed, U. S. A.; and P. N. Elderkin; and Economical Section of Water Conduit for Power Development, by Cary T. Hutchinson. The first of these papers appeared in abstract form in the April issue of MECHANICAL ENGINEERING (p. 369) and the second, also abstracted, in the June issue (p. 527).

EXCURSION TO DETROIT

About two hundred and fifty members joined in an excursion en route to the Spring Meeting, there being representatives from the principal cities between New England, on the north, and Birmingham and St. Louis on the south. About two-thirds of these gathered at Buffalo on Saturday morning, June 14, where they were met at the train by members of the Buffalo Section who devoted the day to entertaining the visitors, taking them from place to place by automobile. The plants visited included the Lackawanna Steel Company, Larkin Brothers, Lumen Bearing Company, the steam power plant of the Buffalo General Electric Company, the Pierce Arrow Motor Car Company and the National Aniline & Chemical Company.

It is the desire of all those in attendance at the Spring Meeting of the A. S. M. E. at Detroit to express their appreciation to the Detroit Committee for the splendid reception accorded and for the complete and satisfactory way in which the local features of the convention were handled. To the Committee on Meetings and Program, on whom the final responsibility for the program rested, great credit is due; and to the Aims and Organization Committee, the Research Committee, the sub-Committee on Gas Power and the various Local Sections, particularly Detroit, Chicago and Cincinnati, appreciation is due for their contributions to the success of the professional sessions.

In the afternoon special cars were furnished to take the party to Niagara Falls and over the Gorge Route. A few of the members visited some of the hydroelectric plants in preference to taking the scenic ride.

The Buffalo contingent left on the Steamer *City of Erie* arriving at Cleveland Sunday morning, where the group of members who had gathered there the previous day boarded the vessel.

Simultaneously with the visit to Buffalo these other members were being entertained at Cleveland by the members of the Cleveland Engineering Society and the Cleveland Section of the A. S. M. E.

The plants visited at Cleveland included the Pennsylvania Ore Docks, where special arrangements had been made to have a vessel in process of being unloaded; the Upson Bolt & Nut Company, and the Wellman-Seaver-Morgan plant.

On Saturday afternoon, owing to the plants being closed, the party were taken by automobile for a ride through the beautiful park system of Cleveland, arriving at the Cleveland Yacht Club in time for dinner, which was followed by dancing and other entertainment.

The thanks of the Society and the members participating are due to the members at both Buffalo and Cleveland for the painstaking effort and attention which they gave to making both groups feel at home and enjoy their brief stay. These members met the incoming parties at seven o'clock in the morning, and stayed with them throughout the day and evening, and no effort was spared to arrange for their comfort.

Leaving Cleveland the *City of Erie* proceeded to Cedar Point, where a special dinner was served at the Hotel Breakers and opportunity was had for bathing and other recreation. After a rest of four hours at Cedar Point the party boarded the steamer *Put-In-Bay* and proceeded to Detroit, where the boat arrived shortly after 10 p. m. A stop was made at Put-In-Bay, where Commodore Perry fought and won the Battle of Lake Erie. Here was seen the beautiful memorial monument erected in his honor.

COUNCIL AND LOCAL SECTIONS LUNCHEON

Sixty Council members and Sections delegates had the opportunity of meeting together at luncheon on Tuesday. Mr. D. Robert Yarnall, Chairman of the Committee on Local Sections, presided, and called upon President Cooley, Past-President Hollis and Lieut.-Col. E. H. Whitlock, the first chairman of the Committee on Local Sections, to make short addresses.

These addresses were of an inspirational character, Dr. Hollis pointing out that the nobility of the engineering profession was dependent upon the degree to which that profession promotes the common good and emphasizing that every engineer should pursue his profession to the end that the world will be just a little bit better for his having lived in it.

Colonel Whitlock gave a brief resume of his experiences in France with the 24th Engineers.

In his opening remarks Mr. Yarnall called attention to the fact that there are now 32 cities where meetings of the Society are being held regularly, seven Sections having been added during the current fiscal year. These are located at Cleveland, Washington, Eastern New York (including Albany, Troy, Schenectady and Watervliet), Rochester, the Mid-Continent Section (with headquarters at Tulsa, Okla.) Virginia Section (with headquarters at Richmond) and a Colorado Section (with headquarters at Denver). The last mentioned was authorized at the Council meeting held in Detroit on June 16. This is an increase of 33⅓ per cent in the number of Sections, and indicates the extent to which the Section movement is taking hold.

During the convention plans were made to hold during the coming fall a Joint Mid-Sections Meeting at Indianapolis. This was to have been held there last October, but it was interrupted by the epidemic of influenza. The date has not yet been decided, but there will be in addition to a meeting under the auspices of several Sections, a meeting of the Council, and, probably, a dinner and excursions. The meeting will probably be held on October 17 and 18, and should attract a large gathering of members because of the central location of Indianapolis.

LOCAL SECTIONS COMMITTEE MEETING

During the course of the meeting the Committee on Local Sections held a five-hour session during which plans for the forthcoming year were discussed, at considerable length. Among other things the Committee will make a comprehensive analysis of the membership by Sections during the summer, and keep closely in touch with a number of localities where the members are contemplating the formation of Sections. A statement is being prepared showing the methods of procedure in the formation of a Section; and the various advantages accruing to the members of the Society and also to the local engineering organizations which may already be established.

Members of any locality interested in holding meetings are encouraged to correspond with the Secretary, and every assistance will be given them in planning an organization meeting.

ENTERTAINMENT FEATURES

On Monday evening the Local Committee arranged an informal reception in the ballroom of the hotel, with a brief address of welcome by Mayor James Couzens, to which President Cooley replied. The reception was followed by dancing and refreshments, and it may be said here that on all occasions when opportunity afforded, the evident desire of the members to be festive was shown in this way under the leadership of the Chairman of the Local Committee, H. H. Esselstyn, who proved as capable a director of dancing as of other and more weighty affairs.

On Tuesday evening all gathered at the Arena Gardens, the large convention hall at Detroit, which was beautifully decorated. An enjoyable concert was given by the Burroughs Band, and every one felt impelled to join in the dancing which followed. The large floor was well filled until a late hour. Refreshments were served during the evening.

On Wednesday was the crowning event, consisting of the sail on Detroit River and Lake St. Clair and through the St. Clair Flats, the picturesqueness of which delighted everybody. This trip, which lasted throughout the afternoon and evening, gave a rare opportunity for meeting members and friends from all sections of the country. Both the Council and the Sections Committee held meetings during the trip. Dinner was served on the boat, and although the number was large and facilities necessarily restricted, the dinner was excellent and well served.

Many ladies were in attendance at the meeting and the Ladies' Entertainment Committee of Detroit were alert to every possible attention to their guests. Automobile trips were provided, there was a drive around beautiful Belle Isle, luncheon at the Detroit Boat Club, Tea at Red Run Golf Club, and opportunity was offered to inspect many points of interest, including the United States General Hospital, the Art Museum, and Priscilla Inn.

LOCAL AND GENERAL COMMITTEES

The following is a list of the Chairmen of the various local committees which each helped to make the meeting a success and to all of whom the Society desires to express, for the membership, its thanks and appreciation as embodied in the vote of appreciation taken at the closing session. The faithfulness and efficient service rendered by the local members will be long remembered. General Committee, H. H. Esselstyn; Reception, James Couzens; Printing and Publication, John C. McCabe; Transportation and Information, W. E. Cann; Hotel, Thurlow E. Coon, Entertainment, M. W. Taber; Ladies' Entertainment, Mrs. F. G. Ray. The Detroit Local Section committee, E. C. Fisher, chairman, contributed two excellent papers to the meeting.

The work involved in directing the entertainment for so large a convention as this is necessarily very great. The committee members, however, had their work so well organized that every feature was carried through in an admirable manner, without confusion or delay.

The general plan of the meeting as a whole, and the details of the professional program, were under the direction of the Committee on Meetings and Program, Dexter S. Kimball, Chairman.

TRIPS TO INDUSTRIAL PLANTS

Unquestionably one of the appealing attractions of Detroit as a place of meeting for engineers is the opportunity for visiting the various industrial plants which have so much of interest.

The first of the regular trips was on Tuesday morning, to the well-known plant of the Burroughs Adding Machine Company, where luncheon was served for the visitors. In the afternoon trips were made to the plant of the Anderson Forge and Machine Company and the calorizing plant of the Diamond Power Specialty Company. On Wednesday morning a large party went to the Connors Creek plant of the Detroit Edison Company, where luncheon was also served. This plant has a number of unusual features, particularly in relation to the operation of the auxiliaries.

On Thursday a large number visited the Ford Eagle plant, where they witnessed the launching of one of these boats. In the afternoon trips were made to the Ford and the Packard plants.

Automotive Engineers See Work Ahead

President Charles W. Manley, in opening the summer meeting of the Society of Automotive Engineers, held at Ottawa Beach, Mich., June 23 to 27, declared that to those having to do with matters of automotive engineering, which includes the designing and building of automobiles, tractors, boats, aircraft and engines, as well as the planning and organization of their operation, the opportunities and obligations knocking at their doors demanded the acceleration of minds and energies to the highest degree. "The real work of the automotive engineer in these fields," President Manley emphasized, "has hardly yet begun. For instance, in the case of the motor truck, these vehicles are daily hauling thousands of tons of merchandize, but the careful study and collection of data for accurately predetermining best operating equipment, organization, and personnel to meet given conditions at a predetermined cost, has hardly been started. This single phase of automotive engineering presents the problems that the determination of freight rates would if all our records and data of railroad transportation were suddenly swept away and it became necessary to reëstablish them."

Professional features of the convention comprised a truck and fuel session, at which were brought out the trend of truck design, and the motor-fuel problem; a passenger-car session devoted mainly to a consideration of the probable characteristics of the car we will be riding in ten years from now; an engine and tractor section, including a paper on the relation of tractor to implement; and an Army and Navy session, divided between a description of the N C Boats and future relations between the automotive industry and various army departments.

The professional sessions were all held in the mornings, the afternoons were left free for sports and recreation, and the evenings were devoted to general meetings and entertainments. The general meetings included a lecture on Wireless Telephony by E. H. Colpitts, Assistant Chief Engineer, Western Electric Company, with a striking demonstration of conversation between the meeting room and the city of Chicago across Lake Michigan.

Dr. John Johnston, formerly secretary of the National Research Council, gave a talk to the Society on Gas Warfare, and Lieut.-Col. A. J. Slade, U. S. A., related experiences with the A. E. F. and the Armistice Commission.

Other distinguished speakers were Major-General C. C. Williams, Chief of Ordnance, Col. L. B. Moody, Chief of the Truck, Trailer and Tractor Division of the Ordnance Department, and Lieut.-Col. B. F. Miller, of the Motor Transport Division.

There were over 600 at the convention, the large Hotel Ottawa being filled to capacity and the overflow accommodated in hotels at Macatawa and Waukasoo, both across the beautiful Black Lake. The selection of the place of meeting was a happy one, and undoubtedly the desire of the Meetings Committee to make the meeting an opportunity not only for real accomplishment but also for plenty of fun was fully realized. A complete account of all features is being published in the forthcoming number of the Journal of the Society of Automotive Engineers.

W. E. B.

Discussion on Industrial Relations

At the largely-attended session on Industrial Relations, held at the Spring Meeting, there was presented the report on The Status of Industrial Relations, by L. P. Alford, an abstract of which was published in MECHANICAL ENGINEERING for June; and an initial, or opening address on Industrial Personnel Relations by Arthur H. Young, Manager of the Industrial Relations Department of the International Harvester Company, Chicago, which is given nearly in full elsewhere in this number. Mr. Young's address and Mr. Alford's report were followed by a general discussion, of which an account follows. A large amount of written discussion was also offered, from which extracts have been made for publication. Because of lack of room it has been impossible to give this discussion in complete form, but it is believed what is here presented correctly records the most essential points that were brought out.

MAJOR FRED J. MILLER[1] was of the opinion that the industrial problem resolved itself mainly into the establishment of a business relation between employer and employee of such a character as usually exists between any other classes of people who do business together—relations which must be mutually and permanently satisfactory to each side involved.

The employee must feel that he is doing at least as well as he could do with another employer in the same line, and the employer must feel that he is doing about as well as he could with any other body of employees.

A business relation implies, also, the right of either party to present a proposition at any time for a change in the terms of that relation. It should be agreed that in any negotiations regarding the terms of employment, either side may have the right to be represented by a representative of its own choosing. In these days of large corporations, the owners of a business have chosen, under the name of officers, superintendents, foremen, and so on, men who represent them in all negotiations concerning the business relation that should exist between employer and employee. Nobody disputes the rights of the owners to select such representatives of their own choosing, and if a business relation between employer and employee is to exist, the employees should have exactly the same right to choose their representatives. These may constitute a committee of their own number or they may be union representatives; but so long as they are chosen by the employees they should be treated as their representatives and allowed to state their case.

When an employer has sat down for a discussion across the table with representatives of that sort, whether they be employees of his own or union representatives, or what, and views have been expressed candidly and freely as man to man, it will often be found, as I have actually found, that many of the difficulties which may have been anticipated will disappear; in fact, that thereafter there is no difficulty whatsoever.

An impressive example of this occurred in two factories of which I was at the time general manager, where there was a movement for shorter hours and more pay, although we were already paying about the highest wages that were going. We voluntarily went to the shorter day and gave the men to understand that there could be the utmost freedom in discussing matters relating to the situation but suggested that it would be better if they were to appoint committees of their own number to discuss these matters with us and to present their side, we giving every assurance that no man serving on such a committee should be discriminated against in any way by reason of such service.

There were three classes of employees concerned, tool makers, automatic-screw-machine men and the polishers. The two former appointed committees of their own number of our employees, but the polishers preferred to send a union employee who was not a member of our labor force. He was, however, received just as the committees had been and invited to state his case which he did freely and fully. We stated our case and told him what we could do and what we could not do and why.

When the time for the strike arrived, the tool makers and the automatic-screw-machine men, who had appointed committees of their own, joined the strike, but the polishers did not, although everyone who has had experience with polishers knows that there is likely to be more difficulty in dealing with them than with men of the type of tool makers or screw-machine men. We learned afterward that after his interview this union representative stated at a meeting of the polishers that as a result of considerable experience in adjusting labor matters he had never met those who were quite so ready to hear the other side fairly, squarely and patiently as we had been, and he thought if they knew when they were well off they would hang on to their jobs and refuse to join the strike.

It is safe to say that such a result would not have been prophesied by most people who have had industrial experience; but it is only one of many instances I could relate to show that many of our difficulties which we think are serious in the management of men will disappear if we regard the relation that should exist between employer and employee as one which must be a mutually satisfactory business relation, not a patriarchal relation.

FORREST E. CARDULLO. We have at the present time two conflicting ideas of what constitutes industry. One of these is based on the old idea of competition between all men for the good things of life. It falls back on the proposition that the primary purpose of industry is to make money for the capitalist or owner. Incidently it furnishes a means of livelihood to the worker and in doing so affords the capitalist or owner an opportunity to secure a commodity which he desires, namely, service in exchange for wages. The owner has the primary rights and privileges and the entire control, while the worker is put in the position of competing with his fellow workers in order to dispose of a perishable commodity, service, susceptible only to the operation of the laws of supply and demand.

Now we are coming to a point of view which regards the primary purpose of industry as service to the community and contributory to the general welfare of the nation; while the general welfare of the capitalists, owners, managers and employees who are engaged in the industry becomes secondary.

Our present-day attitude of mind on questions of capital and labor is such that we regard industry as passing from the competitive to the coöperative basis; from the idea of the entire and exclusive control by the owner to the idea of joint control, primarily in the interests of the community. In this we base our ideas on the theory of a democratic government which demands equal rights and privileges for all men. We have the Irishman's fundamental definition of democracy that it is "a form of government where every man is as good as every other man and a damn sight better;" but the trouble in working out the proposition of democracies is that we do not stop at the proper point in the definition, but put in the last clause, which destroys the effectiveness of coöperation and the workability of the definition.

All will admit that every man in the community, no matter what his position, is entitled to certain things such as a normal and healthy physical development; hygienic and sanitary living and working conditions; at least a minimum education which will enable him to discharge intelligently his duties as a citizen; and an equal voice in the control of every activity in which his essential interests are concerned.

Industry is not a war. It is a joint enterprise to be conducted in the spirit of coöperation for the joint benefit of all concerned, whether they be capitalists, managers or workmen.

The defects of the competitive system we have all seen and will continue to see as long as it remains such, which it is liable to do for some time to come. They are (1) that labor is under no moral obligation either to the community or to the employer to give its best, or to coöperate for a joint benefit; and (2) labor believes that it is compelled to adopt forms of organization and

[1] Center Bridge, Bucks Co., Pa.

methods of procedure which emphasizes the fighting power of the union and which develop inefficiency rather than efficiency and a spirit of antagonism rather than a spirit of coöperation. The men in charge of the activities of the union are dependent for their support upon fostering, at least, a reasonable amount of friction, so that they may have something to do and may point with pride to their achievements. Before we can do away with this spirit we must substitute not something which will assure to the workmen a larger measure of the good things of life and larger measure of control in the things in which he is interested.

This can only come about gradually and as the result of economic education of the workingman who must understand what he is to strive for, what kind of men he must elect to take care of his interests, and that efficiency must be the basis for any increase in his material welfare.

DR. OTTO P. GEIER.[1] There is great need today for trained industrial physicians who will not be satisfied simply to be physicians called in as specialists, but who will actually make a contribution to the solution of some of the very difficult problems that are facing industry today. When we take into account that there is, perhaps, a billion dollars' worth of loss in this country per year, at least half of which is preventable by proper medical supervision in industry, then the problem that looms up for solution by the industrial physician, and by engineers and managers, is worth talking about.

The difficulty that I usually find in discussing this question with managers and industrial engineers is that they have such a poor idea of what contributions industrial physicians can make in the plant. If you hire an industrial physician—a man who is simply a finger wrapper, who sees nothing beyond the mere attempt to repair that injured part, then of course we cannot understand each other. If you have a man who is like a machine making medical examinations for purposes of admission to the plant, or who is only serving part time and is giving his thought to developing his outside practice and merely using industry as a stepping stone, then of course we cannot be talking the same language. Again, if you are talking about a cheap man—and I must confess that I have seen very few high-priced men in industry who are serving as physicians—he is not going to have the large industrial outlook, nor the necessary social outlook. He will have none of the training that comes from broad experience of living and working with people and the result will be what you would get in your engineering department if you hired a cheap man.

Industrial Relations means to me that feeling of responsibility which the farseeing management has; that in having large units of society, such as industry, in its charge it has all the responsibilities that a community has toward large groups; that it must exercise all the care in regard to the matters of health and sanitation and safety, and all the things that naturally come up, and perhaps the thing that has not been stressed today sufficiently is the matter of housing—the matter of living conditions.

Many of you know a man out in the field today, who is a personal service man, who is in overalls, and going from plant to plant in this country trying to find out what workmen are thinking about. I recently spent about five or six hours with him to find out, if possible, what his reaction had been as a result of about four months in overalls, working in coal mines, in steel mills, and doing the things that other men do who earn their money by the sweat of their brow.

Perhaps the thing that he stressed more than anything else was the fact that in spite of all the talk that we have had about sanitation, safety and medical examinations, we haven't even scraped the surface. We are not getting this message across to the workmen, and we haven't begun to realize how much we can do for them by actually caring for their health. Living conditions are the things that are making men start this unrest, and they are coming to the factory in the morning tired and miserable and ill at ease with everybody and the world at large.

[1] Director Employees' Service Department, Cincinnati Milling Machine Co., Cincinnati, Ohio.

BOYD FISHER[1] said that he was interested in presenting the social and economic justification for such a plan as Mr. Young had described, whereby the struggle for control in industry might to some extent be compromised.

The problem of the maladjustment of capital and labor is of interest because such maladjustment reduces production. The public is interested because lessened production increases the cost of commodities; and the manager, engineer and capitalist alike are interested because profits depend on rate of output.

As to labor, the speaker said that it had occurred to him (and he had been held to his viewpoint by Professor Jones of Ann Arbor) that one of the reasons why labor willfully restricts and limits output, although it is one of the partners of production, is because it is the one holding the least advantageous position in the apportionment of the production, and in formulating the rules by which that apportionment is made.

This is due to the fact that those who undertake industry pay off all of the other factors of industry before paying labor. They pay rent and interest, they pay the makers of the tools and suppliers of material, they pay the managers and they pay labor, and then they keep what is left.

These factors, other than labor, are mostly beyond the control of those who undertake industry. The manufacturer cannot control rent, for example, and even his paid managers have a bargaining power fixed in part by market conditions and in part by their ability to stay out of the market if the price offered does not suit them. Labor, on the other hand, has no such advantage and has to come into the market without sufficient resources and reserves and take what the market conditions provide. So it has been, at least, in the past.

Inasmuch, therefore, as capital has to pay off all of the other factors at prices over which it has no full control, at figures that must be satisfactory to the other factors before the bargain is made, and does not have to pay off labor in accordance with a bargain that is satisfactory to labor, capital is often able to derive an advantage at the expense of the workers in industry.

Mr. Young has proposed a method whereby labor can advantage itself equally with the other factors, so that, in a sense, it can say whether it will or will not stay out of the market. It can protect itself and get a fundamentally right bargain, which is the first step toward the fundamental need of the public in relation to industry, namely, to increase production. For with such protection labor has no just grounds for attempting to restrict output.

"I have often felt," said the speaker, "that the measure of our success with the labor problem would be the degree to which we could persuade labor to coöperate in the program of scientific management, which has as its aim, the increase of production. A week ago I was privileged to meet with the presidents of three trade unions to consider a proposal whereby I would be employed to assist in the installation of scientific management in three factories that have for 30 years been in relation with the unions.

"I set up the principle that I would not enter that situation unless the union assented and unless the union would help pay me for the job. The union in question brought in the presidents of two other unions to secure their point of view. I presented the point that hitherto trade unions had opposed scientific management and every other means designed to increase output and that therefore employers who had established relations with trade unions were at a disadvantage in open competition with open shop employers. I presented the point of view, on the other hand, that when the Soviets of Russia took control of industries there, they felt that now that they were in control of industries and were going to reap the benefits of increased output it was up to them to adopt scientific management to increase the output. I said I believed that the unions which the three presidents represented would join in a program for increased output if assured that the gains would be permanent and that the division would be on a permanent basis.

"Those officers unanimously agreed that on that basis they were for scientific management, and that they would employ a firm

[2] Consulting Engineer in Management, 3020 W. Grand Blvd., Detroit, Mich.

of consulting engineers to install scientific management jointly with their employers.

"I mention this incident because it represents an important step forward in the development of scientific management and shows that there is nothing inherent in the philosophy of the workers which restricts output and compels them to limit production to the disadvantage of society, managers and capitalists. The inherent difficulty lies in the fact that capital has the ability to pay off labor and the other factors without labor having an adequate protection of its interest in the bargain."

L. W. WALLACE[1] said that labor problems have always existed and are likely to continue to arise as long as humanity is constituted as it is. He therefore wanted to sound this warning:

"I do not anticipate that at this time or at any future period there will be evolved a panacea that will forever solve any and all problems that may arise between employer and employee. This is no more possible than that a plan can be evolved whereby there will be no more wars between nations. Some form of industrial democracy on the one hand and a league of nations on the other will unquestionably be an agency of great value and influence, but these agencies within themselves will not eliminate labor troubles nor make impossible future wars. In fact, no instrumentality or agency will accomplish much unless there be behind them and disseminated throughout every fiber and thread the spirit of fairness, honesty and justice.

"In all sincerity the principle of the 'Golden Rule' must obtain: do unto your employee as you would have him do unto you. I believe it is the duty of the employer to first demonstrate that he is operating on this principle. It is his responsibility to engender into the minds of the employees perfect confidence, absolute warmheartedness and cordial respect for him.

"It is also my conviction that no man will ever succeed as a leader of men and solve the industrial problems, unless he has a large store of human sympathy in his heart. Unless we are sympathetic, we are cold and indifferent to those matters that are nearest and dearest to men. We are apt to be impatient with human weaknesses, we are apt to make demands that are unfair and unreasonable, and we are apt to be cruel in our decisions and rash in our actions. Unless the principles enunciated are carried out, no satisfactory results will be obtained, whether the plan is a committee system, an industrial democracy system, or a House and Senate plan. The plan or the machinery whereby you are to operate is not nearly so important as the motive that prompts the ideals and the sincerity that obtains."

SAM H. LIBBY[2] stated that they had had a coöperative committee in operation at the Sprague Electric Works since last December. Ninety per cent of the 2000 employees voted to try the plan, which is much like that described by Mr. Young. In the Sprague committee, however, the elected members number about two to the hundred, with chairman, vice-chairman and secretary. Three members were elected to each of six sub-committees and on the sub-committees the management appointed three other members, making six members each. These sub-committees each selected a chairman, which in every case proved to be an appointed representative, showing the confidence of the men in the proposition. Mr. Libby described at length some of the practical workings of the committee, two examples of which follow:

"One of the committees, which we supposed would be the hardest-worked committee, was that on the adjustment of wages and working conditions. Since December that committee has had but 14 cases to review and the last case, No. 14, was the only one during the month of May, and had simply to do with the question of the men ringing out at 12 o'clock noon. They said they didn't think it was necessary that they ring out when they left the works; they were all in, they couldn't get out of the plant without a pass anyway. They presented a very good argument, the committee went over the details, investigated it as thoroughly as possible, and finally decided that the men were right. So what we thought was going to result in a grievance committee, with questions of wages and shorter hours, did not materialize as such.

"Another evidence of confidence was found in the coöperative committee. One month after the committee was started we voluntarily reduced the working day to eight hours and maintained the same weekly pay. We asked for a vote as to what would be done with regard to piece rates, explaining that it would be a large undertaking to go through all the piece rates of the plant in an effort to change them. It was proposed that the piece rates should remain as they were; and when one was found that was not to the advantage of the operator that it come up to the committee in the regular way or that it be adjusted before it reached the committee. The men had enough confidence in the proposition so that they voted 95 per cent in favor of taking the reduced time, the increased day rate, and allow the piece rates to remain exactly as they were."

RICHARD A. FEISS[1], as the result of a discussion introduced by Mr. Young as to the extent to which the question of management is an engineering problem, contended strongly that it is strictly such and that one's views should be big enough to make engineering stand for the things with which the engineer has to deal today rather than for the mere word "engineering" as defined in the old dictionaries. He contended that primarily mechanical engineering is production. The purpose of a machine is to produce and the machine itself must be produced in the process of manufacture. Many times an engineer has seen the best theoretically designed machine go to pieces in the hands of the average workman, because it had been forgotten that a man had to control the machine and its production, and that its successful operation could not be determined solely by the working drawings on which it is based. How, then, can one say that a problem affecting the man whose labor is assisting in production, or perhaps being replaced by a machine which is designed, does not present what is distinctly and directly an engineering problem? Again, we note that the running of two or three machines in a group is much more complicated than the running of one. It must be evident that the questions of the man and the machine cannot be separated and that their relationship is so essential in securing production that the question of labor and its management is distinctly an engineering problem.

H. F. J. PORTER[2] (written). In his admirable paper Mr. Alford gives excerpts from my article in the *Engineering Magazine* for August 1905, which presents a fairly clear idea of my installation of a factory committee in the plant of the Nernst Lamp Company, in Pittsburgh, in the winter of 1903-4, which I understand was the pioneer installation of its kind in this country. In 1905 I presented a paper before The American Society of Mechanical Engineers entitled The Realization of Ideals in Industrial Engineering, in which I referred to the merits inherent in enlisting the interest of the human element regarding matters affecting it in the management of an industrial plant. The basis for this paper was the experience obtained with my shop committee in the Nernst Lamp Company.

When I took charge of that plant it had failed twice and my study of conditions there assured me that one of the reasons for the failures was the autocratic management under which it had suffered. I had for a number of years kept in close touch with several Western plants, particularly the National Cash Register Company, in which welfare work had been carried to a very high degree of perfection, but I never liked the phrase "welfare work" nor the method of application of its principles.

When I took charge at the Nernst plant I decided to install the suggestion system used successfully by the National Cash Register Company, but disliking the method of handling all such features for the management, I determined to have the suggestions passed on first by a committee of the employees themselves and, therefore requested the latter to elect by secret ballot a representa-

[1] Director of Industrial Education, Red Cross Institute for the Blind, Baltimore, Md.

[2] Managing Engineer, Hoist Dept., Sprague Elec. Works, Bloomfield, N. J. Mem. Am. Soc. M. E.

[1] Genl. Mgr., The Joseph & Feiss Co., 2149 W. 53d St., Cleveland, Ohio. Mem. Am. Soc. M. E.

[2] Industrial Engineer, 200 Fifth Ave., New York. Life Mem. Am. Soc. M. E.

tive to it from each department. The committee so formed elected its own chairman and secretary and all suggestions were collected from the boxes by the secretary and prepared by him for the committee.

Among the questions considered by the committee were the following:

Wage Payment, the premium system being finally adopted.

Permanency of Employment. The committee considered the taking on and laying off of all employees and succeeded in stabilizing the working organization, developing functions now accorded to an employment manager. As far as I know it was the first time that "labor turnover" was seriously considered. As Mr. Alford states, my ideas on this subject were reported to the Society in the discussion of Mr. M. W. Alexander's paper on A Plan to Provide for a Supply of Skilled Workmen, at the Annual Meeting of the Society in 1907.

Sickness and Accident Prevention, resulting in suggestions for safety and the appointment of a nurse in charge of an emergency hospital and a visiting physician.

Fire Drill. There had been a panic due to a false alarm of fire in the factory before I took charge, which led to the development of a factory fire drill. I found to my surprise after a canvass of representative factories of the country that further than developing a fire-fighting brigade for handling the hose, etc., no such thing as a fire drill existed anywhere. The fire drill at the Nernst plant was the first established anywhere, which at a given signal would take the employees out of a factory building in quick time. A further study of the problem showed that all factories were deficient in exit facilities and when the Ash Building fire occurred in New York in 1911 I was able to bring to the attention of the authorities the necessity for establishing factory fire drills generally, so that laws were passed in New York State making them compulsory and limiting the number of people in a factory to the capacity of the exit facilities, and these laws have since been adopted in practically all the states of the Union.

Mr. Alford refers to the fact that my shop committee was composed of workmen and foremen and that the superintendent presided. The first committee was formed wholly of working men and women, but as they were advanced to positions in the management and the employees reëlected, some of them to office, some foremen were on the committee and the superintendent was made chairman.

The second shop committee which I installed was in the Nelson Valve Company's plant in Philadelphia in 1907. Here we had a shop committee of workers only and an advisory board composed of foremen and the superintendent. I think this arrangement will be found to give the greatest satisfaction.

Mr. Alford mentioned in his paper that it does not seem pertinent to devote space to certain activities that classify under the definition of industrial relations. I feel that he minimizes the importance of some of these features, particularly the suggestion system, benefit associations and pensions, which seem to me to be of as vital importance as profit sharing, methods of wage payment, the safety first movement, employment management, mutual or joint control, etc.

Take, for instance, the suggestion system. It is a factor absolutely vital to the successful operation of a committee system of employees' representation in management, for there is no other means of bringing to the attention of the committee in a satisfactory way grievances or suggestions for improvement, or any other matters which the employees desire to have discussed. All these matters should be put down in writing at the time when they are fresh in the mind of the writer and signed by him. If they are postponed until letters can be written, or if they are left to be verbally transmitted to a sub-committeeman they rarely reach the committee in the way the authors intend, and sometimes not at all, which leads to dissatisfaction.

In the past when the foreman was the autocrat of the shop, the suggestion system was considered by him to be a reflection upon his capability and he worked against it and practically killed it, and it is now seldom heard of. Even the men who have introduced committee systems do not seem to know its value and have not installed it. When properly installed the suggestion system is a wonderful source of improvement in any factory. Many matters which I found had been installed previously by the management and had been dropped as failures were later suggested by the employees, installed and succeeded.

Scientific Management, always difficult to install in a factory under autocratic management, goes in as a matter of course under committee management.

CYRUS MCCORMICK, JR.[1] (written). Employee representation is the first consideration today, because however much emphasis is being placed by workingmen on shorter hours, higher wages, and better working conditions, their underlying motive is really an expressed desire to share in the management of a business as it affects their own interests. Employees and employers are both finding that it is necessary to develop a new foundation for their mutual relations which shall be founded upon something more than a cash basis.

Employee representation is the practical application of the theory of democratic industry, because it permits employees to speak their minds through chosen representatives and to make their collective will effective. The recent war has proved that democracies—however slow they may be to act—are capable of generating a momentum based upon popular sanction which is not to be found in any autocratic system. This momentum is due principally to the good-will resulting from the self-expression which constituents of a democracy are capable of producing. It is the newest application of the old Roman fable of the "bundle of sticks."

I disagree profoundly with Mr. Alford's statement that "students of the present condition of unrest have pointed out that the fundamental is a struggle for control, the opposite forces being the owners and the workers." The idea underlying employee representation is not a question of class struggle, but rather of removing class distinction. It is a constructive endeavor to secure added benefits which are not granted by our present system, rather than a restrictive effort to prevent the spread of ills incident to industrial warfare. It may, it is true, prevent the spread of these ills, but if it can not at the same time ameliorate conditions, it must philosophically be regarded as a failure. The first two principles of employee representation hereinafter described prove these points.

Employee representation must be characterized by one application or another of the following fundamental principles:

1 There must be full representation for employees concerning working conditions, protection of health, safety, wages, hours of labor, recreation, education, and the like. This statement, of course, involves a recognition of the right of collective bargaining. It assumes that the workers, individually and as a group, are intellectually capable of maintaining their share in the joint discussion with chosen representatives of the management.

2 Joint conference between men and management. It is not sufficient to grant the employees merely the right to discuss their own affairs. This discussion must take place with the management or its representatives. If any subject can be brought out into the open where it can be tested by the clash of men's minds and where honest opinions are exchanged in free and frank discussion, a happy solution of any debated point can not be long delayed. The fundamental point is to get together; to talk things over; to debate them; and so to understand each other's opinions and points of view.

3 Shop committees differ only in the basis of representation. The great point is to secure a sufficient representation to build the plan upon an essentially democratic foundation.

4 Employee representation must include an easy channel of approach from the lowest workmen to the highest official in the company whereby the former can appeal to the justice of big minds. In this way it is to be hoped that personality can be reintroduced into industry without depriving industry of the efficiency of broad organization.

5 There must be no discrimination on account of race, sex, political or religious affiliation, or membership in any labor or

[1] Works Manager, International Harvester Co., Chicago, Ill.

other organization. This is an essential tenet of democracy, and if it is not included in the groundwork of any plan of committee representation, that committee can not succeed.

6 Finally, there must be executive supervision for the plan. In this way the experience gained from day to day can be collected and coded into a working principle for the future. The handling of labor problems is becoming the work of specialists, and as the years progress the specialist in labor matters will be more and more important even than he is at present. Quoting from Dr. Thurston, Mr. Alford is not clear as to whether he would set up a special labor department in a corporation or would consider Industrial Relations as merely one of the by-products of an industry. Certainly this is not an engineering problem in the narrow use of the word "engineering," nor is it a problem for psychologists or sociologists. It is rather an attempt to translate humanity into the language of modern industry. The whole problem must be looked at, not merely on ethical, but also on economic grounds, and the future development of Industrial Relations will, it is believed, depend upon a satisfactory solution of this dual view of the problem.

MACK GORDON[1] (written). Although the shop committee and collective bargaining outside of trade-union control are comparatively new and untried methods in management, some conclusions can be drawn from the limited experience at hand.

If the worker does not understand clearly what are the functions of the shop committee, and what his part is to be, it will not have his confidence, which is essential.

How is this confidence to be built up? The management must make up its mind absolutely to turn over to the workers the right of bargaining with it on any matter whatsoever that pertains to the workers' interests, such as:

1 Wages. The quantity to be produced for those wages. The method of determining what the quantity to be produced shall be, such as time study. Individual requests for increase in pay
2 Hours of work
3 Any rules or regulations affecting the conduct of the worker
4 His right to a hearing in case of discharge.

More than five years' experience has proved that the workers are reasonable. As long as there is confidence in the committee and in the honesty of the management, they will remain so. They do not ask for impossible things and when they do it is only because of lack of knowledge as to conditions. A frank and honest discussion will soon dissipate the misunderstanding.

However, the mere existence of a shop committee that can present grievances, ask for increases in pay, changes in hours, review of discharges, etc., is not enough. When the committee finds something wrong and asks that it can be remedied, in the most important cases, the conditions can only be remedied by a change of manufacturing policy, or of methods of management. The management must be willing and able to make these improvements. If it cannot, the mutual confidence that is so necessary will be dissipated, due to the lack of ability to satisfy the workers. It is in this phase of the situation that scientific management can help to solve the problem.

WILLARD G. ABORN[2] (written). In the first place the employer must be entirely convinced that the employee committees can and shall work out to the mutual benefit of all concerned. Fair-mindedness on the part of the employer and a willingness at the beginning to go more than half way to convince his employees that he is earnestly endeavoring to bring about a mutually beneficial condition is a necessary preliminary to the successful inauguration of such a scheme.

There have been and always will be dissatisfied radical workers in every plant, whose influence increases or decreases in proportion as the fairness of the employer decreases or increases. Therefore, by all means, in instituting these committees, reduce the influence of these radicals by giving the rationals, who are about 80 per cent, entire freedom in the selection of their representatives; in other words, remove all possible suspicion of undue influence at the elections by arranging that they shall be directly under the supervision of the workers themselves or their representatives. Do not permit any official or foreman to in any way dominate, interfere, or even suggest, except as they may be called upon by the workers for advice.

Elections without nominations seem desirable and have worked out extremely successfully where used, in that conservative employees of long service in the plant have almost invariably been elected. Also the time required is much less and result is really more democratic.

Department committees of three are also recommended for the reasons that three are more constructive than one and when representing their own department only have intimate personal knowledge on any subject affecting their constituents.

Welcome joint discussion on any matter pertaining to the plant—in fact, if necessary or desired, originate matters for discussion so that the committees may function and the workers interest in the plant welfare be stimulated. Those who have had dealings with committees know that there is nothing much more dead than a non-working committee. Joint meetings of employer and employees' committee should be held frequently enough to keep up a live interest. Allowing the committeemen to honestly feel that they are originating and inaugurating matters for common good will tend to keep their enthusiasm alive and working.

GUY P. MILLER[1] (written). Although the plan of Industrial Relations adopted by the Bridgeport Brass Co. has been in operation only nine months the results have been far greater than anticipated. About 100 meetings of committees have been held during this time, at 25 per cent of which hours and wages have been discussed, and in no case has the conclusion reached been other than unanimous and entirely satisfactory to the employees and the management. Every employee has an opportunity to be heard whenever he has a grievance, which enables the company to adjust little things which cause annoyance and to explain other things to the satisfaction of the men. In order to get the greatest benefit out of these committees, the safety and sanitation work, as well as the work of the sick-benefit association with the insurance features, have been turned over to them. Joint committees are also handling recreational and athletic activities in all plants of the company.

Every three or four months an evening meeting of all the committees is held with a dinner in our cafeteria, and I explain the general condition of the business and ask for expressions from the men, which has helped cement the spirit of confidence which has been established. No plan will be successful which fails to instill confidence, but as soon as the men are confident that the management will give them a square deal they will go half way.

Many feel that agitators may gain control of the committees and organize them as union representatives, but I am convinced that this danger is not to be feared as long as the management has the confidence of the employees, and when this is gone no plan can be successful.

P. J. REILLY[2] in a written discussion emphasized the change in conditions since the time about two decades ago when the general manager of a plant erected buildings, engaged help, bought materials and determined costs. He was unhampered by any restrictions as long as he made profits for his company. Now the old-type general manager would find himself unable personally to cope with the new problems which arise and he must be assisted by a staff of officers, purchasing agents, efficiency engineers, master mechanics and employment managers. He pointed out, however, that such staff services fall pitiably short in their appraisals of the worker and of the job as compared to that which was reached when the owner was present in the shop. This is because many good principles of personal management which are developed by the industrial engineer or the employment manager lose much of their effectiveness because they are applied by foremen who have not been trained for efficient foremanship. In

[1] Consultant, 226 Marion Bldg., Cleveland, Ohio.
[2] 619 West 113th St., New York City.

[1] General Manager, Bridgeport Brass Co., Bridgeport, Conn.
[2] Employment Manager, Dennison Mfg. Co., Framingham, Mass.

many factories the foreman is the only representative of the manager that an employee gets to know well. It is important, therefore, that foremen represent an employer in a creditable manner.

The work of industrial engineers and employment managers must be supplemented by a new type of foreman—one who has been trained for his foremanship. The manager of a large New England factory recently stated, "When the science of human relations is as carefully organized as the science of product and quality of product; when the human relations of the foreman in the large factory unit equal the human relations of the manager of the small shop, the managers will have established their credit as fitting leaders and true spokesmen." Information that will assist foremen to administer their departments more effectively should be organized and presented to them in a form that will make the material readily available. The philosophy behind any rules of organization which foremen are expected to enforce should be explained so that they can enforce such rules without appearing arbitrary. Regular meetings for foremen should be held for the discussion of problems affecting the planning of work, the quality, quantity, and economy of production, the handling of new workers and the promotion of deserving older workers. Such meetings are effective in the enlightenment of foremen so that they are in entire accord with the management's policies in each of these fields. Much can be done in the development of foremen by relieving them from duty in their department for short periods so that they can work under the direction of the employment manager, the industrial engineer, or the master mechanic.

Opportunity should be given to foremen to attend special courses on industrial management, or to visit other factories that they may get the broadening which so many of our foremen badly need.

If the industrial leaders will give them the chance, the foremen will learn to treat help with a degree of human sympathy that will result in better team work. They will develop more patience, judgment and tact, and will eventually realize that men under them will produce best when their heads and hearts are in their work as well as their hands.

D. G. STANBROUGH[1] (written). In the last analysis, our difficulties are those of human relations rather than industrial relations, and if we pass from human relations to industrial relations unquestionably some of the specific remedies which Mr. Alford has recommended must be applied. It should be realized, however, that the growth of the factory system does not necessarily mean (*a*) the loss of personal contact; (*b*) the loss of personal knowledge of the work to be done; (*c*) the loss of personal knowledge of the tools and equipment necessary for production, or (*d*) loss due to lack of conservation of effort.

I believe that a wise system of management conserves these relations, and that they will be found to be developed to a higher degree today in many of our industries, than at any time in our industrial history. In fact, I believe that success in meeting present-day conditions prescribes their development, and if this is the case, the natural question is, "How can that development be brought about?" and the answer: "Through education."

With reference to the development of the personal relations, this is a matter of organization. The foreman, in the minds of the workmen, represents the management, and consequently, if we are to be successful in maintaining personal relations, it becomes necessary that we develop a high class of foremanship, and this instruction work must be done by executives familiar with the broad policies of the business and who have had the necessary practical experience to enable them to talk to the foreman from the foreman's viewpoint.

The foreman must be a man of the proper amount of personal kindness and should be able to understand the psychology of management. Such foremen will be found among every class of workers, or at least potential foremen of this caliber, and to develop such men it goes without saying that the factory executive must have the proper viewpoint.

[1] Gen. Supt., Packard Motor Car Co., Detroit, Mich., Mem. Am. Soc. M. E.

I want to take particular issue with the closing paragraphs in the paper. I do not think that we can ever hope for any real measure of success if we are to consider workers in groups or masses. You cannot build morale by appeal to masses. I believe that the appeal must be made to the individual, through the organization line. The spirit of organization can be strongly built up if each individual worker feels that the management is conscious of his efforts and that the appeal is to him personally. Even in a large organization much can be done by the executive in knowing his men. At least he can know a few men in each department, and through them the spirit can be communicated to the organization.

JOHN L. HENNING[1] (written). During the past five years hundreds of thousands of potential business men have been added to our population and practically no new unorganized labor has been added to our supply with which to carry on the work created by this additional ambitious army of business makers.

There is every indication that immigration will be practically stopped for the next four or five years, perhaps longer, and an entirely new situation will be presented: viz., the machinery already in existence supplemented by additional but limited output will be called upon to operate much more continuously (and therefore efficiently) than ever before.

Even with greatly increased efficiency there will not be enough labor to meet requirements, and this is where the engineer will come into action. It is strictly up to him to create new machines and new methods of utilizing old machines to accomplish the required result with whatever labor is available.

With the door closed to disorganized labor from Europe, we will soon become really American and instead of being apprehensive about higher wages, I believe all real Americans will soon be proud of the wages and standard of living afforded our workers in this country.

Those classes which have been rather thoroughly organized for a number of years are doing very well, but there are a large number of classes, such as clerks, stenographers, and responsible employees of banks and industrial institutions that are having great difficulty in providing only the real necessities of life. Many engineers are among the classes that are having trouble in making both ends meet. Large industries cannot do anything that will help them through their present and future difficulties as much as to recognize the wonderful opportunity of the engineer and *voluntarily* place more responsibility on him, at the same time not forgetting to make him comfortable.

As Mr. Alford states, the loss of personal contact is one of the contributing causes of present unrest; but if employers will use the engineer to the fullest extent and permit him to take some responsibility in handling labor questions he will, I believe, demonstrate that his so-called fault of dealing with labor from an individualistic viewpoint may be turned to a very good account. He will use a little more human sympathy in dealing with labor, which after all is simply a collection of human beings who inherently have the same "rights, needs and aspirations" as the employer and those dependent upon their product of industry.

Referring to Mr. Alford's conclusions as to the reasons for the apparent failure of remedies heretofore applied, I have proved to my own satisfaction, in a small way, that reasonable assurance of a permanent job is the greatest single weapon against unrest and Bolshevism. The moment uncertainty as to tenure of job and rates of pay is introduced into a workman's mind he is ready to believe almost anything, and you cannot expect a worker in any class to save for a home when he has none or only small assurances of the regularity and permanency of his work.

WILLIAM M. LEISERSON[2] wrote saying that the tendency of the engineers is to consider workers only as individuals, while the "industrial psychologist" holds that they must be dealt with in the mass. On the other hand, the economist, who has been studying labor problems and industrial relations for more than a hun-

[1] Consulting Engineer, 525 Kirby St., Lake Charles, La. Mem. Am. Soc. M. E.

[2] Working Conditions Service, U. S. Dept. of Labor, Washington, D. C.

dred years, takes a broader view based on a study of the labor problem, its history, and its causes and manifestations under different systems of industry.

The economist, he continued, analyzes industrial relations and finds not one problem requiring individualistic or collective handling, but two sets of problems, one requiring dealing with each worker as an individual, the other necessitating dealing with wage-earners as a class. The first of these may be called the personal relations in industry, the second, the economic or governmental relations. The personal relations include such subjects as recruiting, selecting, hiring, training, placing and promoting workers, looking after their health, safety, comfort and welfare. These problems require individual problems or they are technical questions that must be decided by technical experts like the engineer or the physician. The second set of relations, however, have to do with bargaining, wages, hours, shop government and discipline. These questions are essentially controversial. They cannot be decided by technical experts. They are matters of opinion requiring decision by a democratic majority.

Failing to catch the economist's fundamental analysis of the problem, engineers, employment experts and industrial managers are wont to group all industrial relations together and to include the fixing of just rates of pay in the managers' function. Accurate records of individual production and fairness and square dealing with employees, they think, will assure justice to the workers. This may be true as far as injustices between individuals within a plant are concerned under a general scale of remuneration that is already fixed, but it overlooks entirely what President Wilson has called the progressive improvement in the condition of the wage earner, the raising of the scale of all so that labor may receive a very much larger share of the product of industry than it gets today.

The other day the waiters of the city of Toledo adopted a scale of wages and presented it to the hotels of the city, saying, in effect, "This is what we consider it fair and just to charge you for our labor," and they resented it when one of the employers did not want to pay them what they thought they were worth. They say, "Why should management place the price on labor? It does not set the price on the materials and machinery it buys, why should it on the labor? Why should not the workers set their own price? They know best what it costs to live and to produce the energy we call labor."

Yet from the national point of view neither the one side nor the other ought to be permitted to fix the scale of wages, according to its own ideas of what constitutes a square deal. The national welfare requires that it be set by negotiation and bargaining and mutual compromises and concessions, which cannot be done without the right of employees to bargain collectively with their employers.

H. L. GARDNER[1] wrote outlining in detail the personal qualifications of the employment manager, his duties and the functions of the employment department. He said that the manager should be a broad-gage man, preferably a high executive or an officer of the concern, for which he preferred the title "service manager." He should be of sufficiently large caliber to "sit in" with the officers or a committee responsible for all relations between employer and employee; and being thus constantly apprised of general problems and accepted policies he can then organize and direct his department to coördinate with all other service departments and activities.

Interviewing is perhaps the keynote of his work, and with the right viewpoint and with practical knowledge of plant operations and conditions he can be of tremendous influence in building the right kind of working force. Continuing, Mr. Gardner wrote:

"One of the more abstract functions of Employment Management deserves detailed attention. If we are to offer a satisfactory substitute for the decreased personal contact in industry, the foremen are the channels through which we must work. To the workmen, the foremen are the personification of the manager and the company; it seems vital that such representation should harmonize with the general policies of the concern, yet too little has been done to develop this contact and to insure the desired results. To my mind, one of the most important services which employment management can render, and one which has a most important influence on industrial relations, lies in securing real coöperation of foremen through understanding of, and sympathy with employment methods of attack on the common problems of personnel and production. This may sound too theoretical, but it is, in fact, a tangible problem, and quite possible of surprisingly satisfactory solution.

"At the risk of repeating certain thoughts which I emphasized at the National Association of Employment Managers Convention in Cleveland, I would criticize the average employment department as too selfish. We too frequently devise theoretical solutions for the existing problems and impose them on the plant without sufficient sympathy for the other fellow's opinions and troubles. Complete success demands that the employment department thoroughly acquire the general plant viewpoint and merge its individual activities into the broader service program.

"Several vital changes in the status of employment management have taken place in recent months. War pressure for 'quantity production' has been relieved and the opportunity for intensive personnel work is much brighter. Changing social and economic conditions are making more important the necessity for the right relationships, and, to use Mr. Alford's words, focusing attention on the 'interacting human rights, needs and aspirations in productive industry.'"

MARK M. JONES[1] (written). Functions in industry can be arranged according to many very interesting classifications. The five M's—men, money, methods, materials and machines—have appealed to me as a simple classification. Engineers will recognize that in our progress on the fifth M—men, we have from an administrative standpoint reached a point of about 30 in case we consider progress on the other four M's—money, methods, materials, and machines, as being at 70, with 100 the ideal.

Employment management as a part of Industrial Relations has as its object the administration of recruiting, selecting, placing, transferring, promoting, and releasing workers on an engineering basis. It seeks to apply the labor policy of the enterprise so far as it may affect those functions named. Its effectiveness is only limited by the strength of the belief of the management in the value and possiblities of such a service.

Employment management is distinctly a "service" function. It is an aid to production and a department for the purpose must always be operated with the proper understanding of the important part it plays in turning out the finished product.

A well-organized employment department surrounds the initial contact of the worker with those activities which influence him favorably and contribute definitely toward the final object of production. It provides a proper reception place and courteous treatment while the applicant is being studied. It studies him from mental, moral, physical, financial and social standpoints with the object of placing him where he can work to his own best interests. The employment manager knows definitely that an individual cannot work to the best interests of the enterprise unless he is working to his own best interests. The interests of worker and business are identical. From the standpoint of placement there is no divergence. From the standpoint of effectiveness, however, men must be weighed more carefully and a more exact method of so doing remains to be developed.

The whole field is rich in opportunities for pioneering work. During the coming months and years there must be worked out and applied:

More exact methods for measuring men
Better coördination of personnel and production functions
More definite methods for recording meritorious services
More exact methods of promoting workers
A more careful observance of the relationship between cost of living and wages paid
Provisions for care during old age and sickness.

[1] Manager Personal Relations Sec., E. I. DuPont de Nemours Co., Wilmington, Del.

[1] Director of Personnel, Thomas A. Edison Industries, Orange, N. J.

There are also many other problems, each step in which creates more problems in the great game of employing large numbers of men as intelligently in our great organizations as would be the case if but 40 or 50 men were the total number.

If during the coming months engineers will have in mind just one need of this field, namely, the same recognition and study of the fifth M—Men—as of the other factors in production, they can do much in assisting American industry toward the great ideal of industrial nations, which is that of "increasing individual production."

MR. ALFORD'S Status of Industrial Relations is a timely summary of past and present, full of valuable data and epitomized in a warning to be heeded.

HARRINGTON EMERSON[1] (written). I have been requested to contribute to the discussion by notes on Wage-Payment Plans as one of the problems of modern industry.

Wages are but a phase of a much deeper problem. What is the starting point? I paid a man recently $10 for a half hour's work and I received an equivalent in return. When in Alaska I paid day laborers $15 a day and felt lucky to find the workers. I have personally worked for $0.10 for a long day's work and was grateful for the opportunity.

On the one side are the necessities of life: to live morally, to have health, time to study, time for industrial improvement, and to have opportunity; on the other, what the earnings will afford, and again also the market rate for similar services. An empirical equilibrium is struck. Not as high wages as an ideal life would require, but often more than the earnings justify.

But what I recognize is that three conditions enter into work and wages: (1) The basic hourly wage, however determined; (2) the equivalent in output for the hourly wage; and (3) the special excellence of the worker. Of these the third, the individual excellence of the worker, is the most important.

The great truth, as yet only partially recognized, is that the superior worker is worth so much more than the average or inferior worker that any amount of care and supervision and all the extra pay required to secure him is a good and paying investment.

From this conviction it is evident that I am wholly out of sympathy with so-called profit-sharing, which repudiates individuality and makes of business a kind of providence that rains on the just and the unjust alike.

There is no connection between profit and skill and effort. The product of the highest skill may be sold at a loss, the product of malingerers may be sold at high profit.

The extra wage paid for individual competence is not a dole, a gratuity, a present. It should be a measured and full equitable compensation for a measured delivery.

There are current wages so low as to be dishonest. There are also current wages so high as to be dishonest.

Starting with a basic hourly rate, increased yield should command higher pay as long as unit costs drop. An increase in wages that increases unit costs (unless money is falling in value) is robbing the three other divisions of the community.

The problem always is to so lower costs as to increase output, to lower unit costs yet to pay more per hour, to give greater security and volume of investment yet to lower interest and dividend rates, to so compensate executives as to stimulate them to secure the best combinations of men, materials and machines, thus again lowering unit costs and adding to the common fund.

Out of the common gain from reduced unit costs only four classes can make a gain:

1 The buyers, who are entitled to a permanently lower price if they continuously buy either more or more regularly or in standardized form
2 The provider of equipment, whose temporary risk must be temporarily covered not only by interest but by insurance against loss
3 The worker, whose only claim to higher compensation rests on a reduction in labor unit costs
4 The administrator, organizer, inventor, man of original and creative personality, who is entitled to the worm the early bird catches.

Fundamentals, not expedients, underlie all real solutions of the wage problem.

R. G. A. PHILLIPS[1] (written) To my mind industrial relations problems came into being along with the "Big Business" idea and I think it well and timely that we give these various problems serious thought and study.

In our industrial relations work at the works of the American Multigraph Company the biggest topic of the day is our industrial democracy. Therefore, although it comes last in point of things done, it ranks first in order of importance.

In our case Industrial Democracy was no "spur-of-the-moment idea." It is a subject we have been studying almost as long as we have been in business. Our active interest dates back about five years—we have been all that time progressing toward our goal. It took about a year and a half of constant study before the final plan with its constitution became a fact. It took definite shape toward the end of February, 1919, and finally on March 1 the plan was put up to the employees.

The plan of putting it up was interesting—I don't recall having heard of it being done our way before. We mailed a letter, over President Osborn's signature, enclosed with it a book describing the plan and the constitution, and sent it all to the employees' home addresses. The letters were so timed in the mailing that they should reach the homes Saturday morning. We wanted them to be part of the Sunday reading program, and had a "hunch" that they would also be part of the Sunday conversation program. We figured that the more a person had to talk about the plan, the more thorough would be his understanding. We also figured that inasmuch as the envelopes bore the return card of the American Multigraph Company, by the time Mr. Man got home there would have been quite a bit of curiosity aroused. We figured strongly on the question, "John, there's a letter come for you from the company—what are they writing to you about?" Later developments proved that we were right in our judgment.

Along with the letter went a pledge card. The employees were asked in the letter to read the plan over; talk it over, and come in the following Monday to President Osborn's office and tell him frankly what they thought of the idea. If they liked it and were in favor of it they were asked to sign the pledge card. If they were not in favor of it or distrusted it they were asked to tell Mr. Osborn what they thought and he tried to "sell" them on the real purpose of the plan.

About 95 per cent of the people accepted the plan with the greatest enthusiasm. About one per cent prophesied dire failure. About four per cent thought it was some sort of a trick. This last class was most amusing. Its members admitted that so far as they knew the company had never gone back on its word to the men. It had never played any tricks on them, had always been square and all that—and then they would hesitate, and the silence would speak volumes for the broken pledges that had made up their experiences before they came to us. I don't blame men for being suspicious. Some of the stories we have heard would break the faith of the strongest of us. There must be no more of it. A square deal must be what it says.

Perhaps, in telling of the steps leading up to our installation of Industrial Democracy, it may be thought I am laying too much stress upon a detail. I am not. The success of the whole plan depends upon the introductory steps.

Well, we had our elections—lots of competition between rival candidates; lots of campaign speeches; lots of real old-time election enthusiasm—even one case of election fraud! Immediately upon taking office the congress turned its attention to that one case of election fraud, with the result that those concerned were eliminated,—three of them. That bit of serious-minded justice was startling, a true index of the seriousness with which the men took their new jobs.

Since then we have had many incidents that have made us wish

[1] Director, The Emerson Engineers, 30 Church St., New York City.

[1] Vice-President, The American Multigraph Co., Cleveland, Ohio.

we had started sooner. For instance, I will refer to some of the minutes of the congress meetings and pick out suggestions that were approved by the senate as being wise and necessary.

Educational Committee: Suggestion that certain employees be taught what the Multigraph does so they might do their work with greater understanding. (Assemblers and final inspectors)

Production Control Committee: Suggested rearrangements of departments that will produce greater results

Suggestion Committee: Presented about fifty new ideas, the principal one of which will result in considerable saving in handling of tools, etc.

Sales Coöperation Committee: Working all the time with Sales Department. Pushing manufacturing and keeping up standards. Latest job the reduction of time taken to fill and ship foreign orders about 80 per cent

Sanitation and Safety Committee: Always at work. Producing great results. Total suggestions adopted to date, about 65

Recreation Committee: Managed several dances, an indoor baseball league, bowling league and all gymnasium classes

Spoiled-Work Committee: Very active. Reported last week on correcting a condition that reduced scrap and increased production on a certain part about 150 per cent

Shop Training: Manages all class work during season just finished. Promoted mathematics classes (two each week after hours) and a big general shop efficiency class that met every Friday night, having an average attendance of 150.

Industry has got to begin to get all the effort it is buying. It should no longer be satisfied with the services of the hands of its workers—the brains, too, must be induced to participate. This matter of brain and hand cannot be commanded either—it must be more of a pull-together effort. We think we are headed that way through our Industrial Democracy.

C. B. AUEL[1] (written). Both capital and labor have within their ranks elements of sufficiently radical tendencies and proportions to cover them at times with opprobrium in the estimation of the public at large, and it is these two elements, which might be termed the arrogant and the ignorant, in their own midst, that each must get rid of, if they are to make the most headway in their common progress.

It seems almost certain that the six lines of development listed by Mr. Alford will go a long way, if fairly universally adopted, toward lessening industrial unrest; but, they will hardly eliminate it since the fundamental cause for this unrest as admitted by the author is fear of unemployment, and methods of overcoming it have not been included. Some persons may point out in opposition to this statement that during the recent period of tremendous industrial activity, labor unrest was perhaps at a maximum; but, in answer to this it may be said this unrest was quite abnormal, due very largely to war conditions, and was moreover aggravated by employers practically bidding against one another in the labor market, with the very natural consequence that labor tended to oscillate to and fro, wherever wages were highest, or in the contrary event to insist on wages being brought to the high level.

One very important item the author has omitted from his list is "Americanization," which has been carried on by many corporations for a number of years past, principally through the medium of schools for their employees; but, fine as is the work already done by them, the task is so huge that it needs to be supplemented by greater efforts on the part of the various states if real headway is to be made. In Pennsylvania, for example, one authority has announced that with a population of 8,000,000, there are 1,500,000 foreigners over the age of 10 years and of these half a million cannot read or write English, while a third of a million cannot read or write any language, but what is worse than these statements is the further fact that the half-million that cannot read or write English increased to this figure from a quarter-million in the short space of 10 years. Illiteracy is a fertile field for the propagation of every kind of "ism" and it seems astonishing that a condition like this should exist in any state in our Union, and doubtless a similar situation exists in certain other states.

DWIGHT T. FARNHAM[1] (written). At the close of the paper Mr. Alford opens a question whose just solution will, I believe, within the next ten years tax to the utmost the ability and resourcefulness of our financial, economic, ethical and engineering minds. The fact that the International Harvester Company had hardly installed their "industrial democracy" plan before they were deluged with recommendations for rate raises illustrates this trend. When their committeemen, however, were taken to the company's books and shown that the business could not continue if their demands were granted, unreasonable demands for the most part ceased. From the standpoint of human relations, then, the first general principle necessary in order to establish a sincere industrial democracy would seem to be the possession of profits which will survive the light of public opinion.

The fair division of the rewards is the question which we face, and it will call for the development of the general principles under which controversies may be adjudicated. The first step is perhaps the establishment of a fair return upon capital which is so invested as to be reasonably secure. The next step in logical order to insure stability would then be the determination of adequate sinking funds to make reasonably certain steady dividends from each sort of business. Setting up such reserves would take investment in industrials out of the gambling class and would make them attractive at a 6 or 7 per cent return instead of having to offer chances of 15 to 20 per cent in order to sell stock.

One of the rocks upon which profit sharing has in the past gone to pieces has been its call upon the workers to share in the sacrifice during dividendless periods. The other has been the determination of the share to which labor is entitled. The solution of such questions requires first the scientific analysis which the engineering mind is best qualified to make.

What Mr. Alford describes as the second great tendency in the development of industrial relations,—the willingness to consider the workers in groups—I interpret as not so much a plea for an understanding of mass psychology as a plea for that knowledge which brought the ancient Greeks to the belief that he who understood life was all-powerful. Every age has had its interpreter of motives which actuate humanity. Today the human psychologist is an industrial psychologist. We applied the mind of the engineer first to materials, then to machines. Now we have reached labor.

C. E. KNOEPPEL[2] (written). Through organization and specialization in industry, relationships have each year become more and more complex, so that today this great problem of human contact is by far the most important confronting us, and my prediction is that from now on Industrial Relations will be considered the keystone of the industrial structure.

I am therefore pleased indeed to see that The American Society of Mechanical Engineers is giving this matter of Industrial Relations the prominent place it occupies. If the engineering world does not give the subject attention, where will the initiative come from? From the workers? No. From the employers? No. I say "no" in both cases advisedly, because in the last analysis each side is generally suspicious of the other's motives when suggesting improvements having to do with human relationships.

The world-wide tendency toward socialism and revolution in ideas, if not in acts, is due not so much to desire for political changes as to a demand for economic changes. What the great masses of people want are homes, food, farms, clothes, jobs, wages which balance cost of living, participation, representation in affairs, opportunity for self-expression and development.

The gigantic convulsion the world is now going through seems to me to be a protest against the way modern society is organized, against much in the present plan of man-to-man contact. The purpose of the coming era, as I see it, is to find the right basis, and this the people the world over will do, regardless of the strife and bloodshed necessary to its accomplishment.

[1] Director of Standards, Processes and Materials, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. Mem. Am. Soc. M. E.

[1] Cons. Industrial Engr., 3rd Natl. Bank Bldg., St. Louis, Mo. Mem. Am. Soc. M. E.

[2] Pres., C. E. Knoeppel & Co., Inc., Industrial Engineers, 6 East 39th St., New York City. Assoc.-Mem. Am. Soc. M. E.

Industrial Personnel Relations

By ARTHUR H. YOUNG[1], CHICAGO, ILL.

THE present focusing of attention on personnel relations, I think, will result in a new era in industry—as much an epochal change as we have had through various fundamental causes heretofore; such as the change from the original craftmanship to larger shop organization, made possible by power development, power transmission, changes wrought by methods of communication, and refinement of the methods of transportation, the era of consolidation of interests, and so on, and one has to stop and wonder why at last we have come to the consideration of the human factor.

We have probably had as great a refinement as would produce any revolutionary changes in machinery and methods and practices in everything except that relating to the human factor. All of us here have witnessed the birth and the growth and the final development of the safety movement, and more recently, too, employment management.

I refer to those, particularly, as factors in personnel relations of today, and illustrating how rapidly changes are coming about. I think it was only back in 1906 that the first organized effort in safety was made. It is generally credited to the South Chicago plant of the Illinois Steel Company, under the leadership of Mr. R. J. Young. He was a sort of genius who suddenly discovered that accidents were preventable—that it was no longer necessary to kill and maim men as a part of the making of steel.

Development of the Safety Movement

At first not much attention was paid to his proposition, but it rapidly gained support, due to its humanitarian appeal, its evangelical aspect. The first attack was naturally very largely along mechanical lines—the removal of projecting set screws and other parts of revolving machinery, the railing of platforms, the guarding of gears, changes in construction, marking of aisle spaces, and all such things.

A very disappointing result was had, because at the end of two or three years, after several hundred thousand dollars had been spent, at that particular plant accidents had not been reduced over 20 per cent, and generally speaking, today safety engineers rate the mechanical factor or the correction of engineering practices as not contributing more than 20 per cent to the possible efficiency of the safety movement.

It was immediately discovered that the real problem was psychologically to teach a naturally careless man to become habitually careful, and that more than 75 per cent of our accidents were preventable by a correction of habits of thought—of thinking safety all the time. To illustrate: It is perfectly natural to cross a street just exactly as a chicken does—to look neither to the right nor the left, but step right out from the curb; and it is only by a process of education that we learn to pause at the curb and look up and down the street and then walk into the middle of the street and then glance again, and finally to cross the street. That is a process of education which will prevent accidents, and it was what was immediately arrived at in industrial safety engineering.

The shaping up of that problem brought its immediate solution, and brought into play a most interesting development from the laboratory of safety engineers. We had movies, bulletin boards, mass meetings, and finally the formation of public safety councils, the introduction of the study of safety in the schools. Its serious considerations by civic police departments and other parts of society is really the product of the industrial safety engineer, because he realized that in order to make a man think safety all the time it was necessary to work on him not only while he was in the shop, but at home as well. And he carried his message to the man in the shop through his children whom he encountered at school, and during the hours that he was walking to and from the plant or riding to and from the plant by public safety bulletins and so had a continuous propaganda working 24 hours a day in order to make him think safety.

Immediate results were achieved. Taking again, for example, the South Chicago plant of the Illinois Steel Company, with which I happen to be familiar, back in 1906 the frequency of fatal accidents in that plant was 47 during the year, or about one a week. By 1913 that rate had dropped to 7, and it has since stayed at about that figure.

As in fatal accidents, so in the less serious accidents, the frequency rate dropped in the same proportion; and in the Illinois Steel Company there has been a reduction in the frequency of accidents to employees on duty of over 85 per cent since the 1906 rate. That was duplicated in nearly every plant of the United States Steel Corporation, and in thousands of other industrial concerns as well.

There have been a number of by-product results which have directly contributed to the growth of personnel movements and industrial relations, as we term them today, growing out of this safety movement. In the first place, it was found that not only did this human interest conserve lives, but that it was a paying proposition; originally it was an interest in the cause of humanitarian principles, and safety was regarded as somewhat of a fad by a great many employers.

After a sufficient period of experience on which to establish definite figures, it was found that safety was really "good business." The Steel Corporation has published the most interesting figures along this line, showing a net saving almost exactly equal to the cost of the safety work, or 100 per cent on the investment.

There is a striking unanimity in the form of organization for efficient safety work. The original movement in 1906 resulted in the formation of shop committees; as soon as it was realized that the problem was one of education of the workman and that his interest must be aroused, means were sought to turn the problem over directly to him, and I believe the first safety committees were organized at the South Chicago plant of the Illinois Steel Company.

Shop committees—the workmen themselves—were given charge of the safety work. It was their duty to investigate the cause of each accident, fix its responsibility, and make recommendations for a prevention of its recurrence. In addition, they were to make regular inspections of the plants, and by their foresight, and recommendations were to prevent, as far as possible, the recurrence of accidents.

That form, possibly modified, is almost unanimously used by safety workers today in all industrial establishments of any size—some form of a shop committee. It may be of the workmen themselves, it may be workmen in one committee reporting also to a committee of foremen, or it may be a joint committee, or it may be a joint committee of workmen, foremen and officers of the company, but the successful safety program of today includes shop committees.

In addition to the definite return on a cash basis of the safety work, there have been several interesting by-products. The first is the reduction of labor turnover. The Steel Corporation's reports recently published, show that since 1906 they prevented, roughly, 25,000 fatal or serious accidents. They rate as serious any accident which disables a man more than 35 days, or results in a permanent disability, such as the loss of a thumb, or an eye, or other member of the body.

Now, it is reasonable to assume that such an injury would require the replacement of the trained worker, and Captain

---

[1] Manager, Industrial Relations Department, International Harvester Company.

Address, slightly condensed, delivered at the Industrial Relations Session of the Spring Meeting, Detroit, Mich., June 17, 1919, of The American Society of Mechanical Engineers.

Fisher and other writers on the subject have given us some interesting figures as to the cost of replacement of trained workers. They vary anywhere from $10 to $200, depending somewhat on the way it is figured, and somewhat on the worker. Of course it is a fair statement to say that steel-mill workers are fairly well trained, and probably $100 as the cost of replacing a trained man with an inexperienced man is not an over-estimate.

If we multiply 25,000 prevented replacements of trained workers, because of the efficiency of a safety movement, by $100, we have a neat little by-product, due to reduced labor turnover through efficient safety work.

And then, too, there was another manifestation. As is generally known, the Steel Corporation has been facing a suit for dismemberment. While the hearings were on several years ago there appeared voluntarily a number of old employees who petitioned that the corporation be not dissolved, because that would mean a return to the days of ruthless competition when they did not have standardized safety programs. Of course, no one knows what effect that action had on the decision, but it presented concrete evidence of the boosting of the morale of the workers through safety work.

The Question of Employment Management

Turning for a moment to employment management, and asking your pardon for a bit of personal reference to illustrate exactly what has been the change in employment methods, I will cite the circumstances of my first employment. I went to work in a steel mill during vacation time when I was thirteen years old. I reported to the engineer and he turned me over to his assistant. The assistant said, "Do you know anything about oiling?" I have said that I was thirteen years old; naturally I knew everything about anything. He said, "All right, here is the cylinder oil, and there is the beeswax and some sand. Here is a ladder. Go to it!" And that was the extent of my instruction in oiling.

The third day I was on the job we had a fire caused by an overheated bearing. I discovered the fire when it first started, threw a bucket of sand on it, and put it out, and by the time the boss got there I had the oil cup in securely, had it full of oil, and was working away with a wire. I told him the oil cup was plugged up. I got away with it. (Laughter.) Quick thinking once in a while will save you your job, you know.

The day following the State Factory Inspector came through and asked me my age. I told him I would be fourteen the next December, and he said "There is a state law that says no one shall be employed until he is fourteen," so I had my first experience of being fired. But I still have distinctly a feeling of horror as I think of the days that I climbed on a rickety ladder, unsafe as unsafe could be, up to a high-speed shaft. In those days we oiled while the machinery was in motion, and the high-speed pulley on one side of me without any protection whatsoever, and couplings and collars on the shaft, had projecting set screws and bolts galore. There was absolutely no thought given to safety.

I well remember the first day I was on the job. An emery-wheel explosion occurred. It was frequent in those days, just as frequent as crane runway accidents were, and those things that you don't hear of any more.

And I also think of the possibility of a great financial loss through the neglect properly to educate a new man in a rather important and dangerous job. If that fire hadn't been discovered within the first five minutes it would have swept through the shop.

Procedure of a Present-Day Employment Manager

Contrast that with the employment program in effect in many shops today. In every well-managed institution there is an employment manager, not necessarily known by that title, but functioning as such anyhow, to whom a request to fill the vacancy of oiler would be referred. In my own case my reception at the gate was somewhat individual, because my father was employed at the plant, but if there had been a vacancy, and no one who was known personally was available, the assistant engineer would have gone to the gate and picked a man from the waiting crowd, and a crook of a finger would have put that fellow on the pay roll. The paymaster would have been informed that this man was oiling.

Today there would be a process of selection. Instead of the group hanging around at the gate, there would be a well furnished employment office with a waiting room, and when the request for an oiler was received by the employment manager, he would go out and seek a man who had some experience or who was adaptable for that position, and he would also know in full the duties and just what specifications he would have to meet in getting the right man for that job.

If the man whom he chose were a foreigner that man would be interviewed across a desk by a man who could talk in his own language, and be invited to tell in full his past experience. If he lied about it, that would show up in the replies to the letters of investigation that are sent out as a rule.

I am not one of those who believe that the employment manager is the final judge of the fitness of a man for the job, I think that rests wholly in his performance on the job, and the foreman is probably the final judge there, but certainly the employment manager can by intelligent first sifting, by coarse sifting, get rid of many palpably undesirable applicants. The applicant who seems after that sifting to be the man for the position would then be given a complete physical examination, not necessarily to reject him if physically impaired, but to make sure that he would not be assigned to a job that would further injure him if he had any physical disability.

If he were acceptable after that physical examination he would probably be told something of the policies of the company; be given an introduction to his employer—the corporation—and be told of its safety program and handed a book of rules of conduct. He would probably be told that this rule book was made up by the Safety Committee, employees in the shop, and that if he didn't fully understand it and wanted to quiz anybody on it he had only to seek the nearest old-timer who had been concerned in the revision of the book, and he would be given full and complete information. Undoubtedly, he would have greater respect for the rules when he learned that they were made by the men themselves.

Then he would be told of the promotional opportunities,—that it was the policy of the company to promote from the ranks, not to hire anybody at a given wage unless they were satisfied that nobody then in their employ at a lower wage could be promoted to fill that vacancy. He would be quizzed particularly as to his ambition. What did he want to be? He would not necessarily be put upon the job as an oiler permanently, but in an efficient filing system for recording applications his ambition would be registered. If he aspired to be a machinist and had stated that he had had certain experience as a bench hand and was attending night school, that would be recorded; and later, when a machinist was desired, preference would be given those applications from employees already in the service. Probably at that time the employment manager would send for this chap and say to him, "When you first went to work here six months ago you were put on as oiler. I understand you are still doing it, and you said you were going to night school to learn to read blueprints and take up manual training, and so on. Just how proficient are you as a machinist? Now I have a vacancy and you might be of use." And possibly he would be fitted into that job.

When he was hired there would be entered on his employee's record card a pretty complete history of him, his social condition, whether married or single, how many children he had, just how many dependents he had, where he was born, his age, his schooling, his military service, if any, whom to notify in case of sickness, result of physical examination and so on, for statistical purposes and then he would be sent to the job on sort of a personally conducted tour. He would be taken by an agent of the employment office, watchman, or special guide, and first shown the gate nearest his work so that any unnecessary hazard of

traveling through a long plant might be avoided in coming to work.

In the meantime, if he were a single man he would be assisted in getting a proper boarding house. If he were a married man, temporarily located in a boarding house, the employment agency would probably show him a map of the vicinity of the plant and the desirable residential districts for his type, and give him a list of reputable real estate men as an assistance to him in locating permanently, and show him the street-car lines whereby he might best get to work. Finally, when delivered to the foreman for whom he was to work, he would be introduced by his own name and learn the name of his foreman. Nowadays, the worker, whether he be foreigner or American born, is introduced to his foreman by name and the guide makes sure that they understand each other.

The foreman probably repeats "John Sobrinski—did I get it right? Well, my name is John Smith. I am your foreman." And the last word of the personal guide is, "The labor supervisor particularly requests you, Mr. Foreman, to give this man any special introductions necessary in the particular hazards of his job." And then and there the foreman, either himself or through a fellow-workman, tells this man something about his job, and introduces him by name also to one or two of his neighboring workmen, so they will know each other, and the man can go to his fellow-workmen and seek and get information.

I know all of us here have probably been on a new job at least once in our lives, and I don't care how brazen we may have appeared then or how brazen the foreign workman or laborer may appear when he first goes on the job, yet down in his heart there is a certain shyness and a certain craving for fellowship, a desire to have somebody that he may know by name, that he could go and ask a few questions of. This feeling exists just as much in the heart of the laborer, be he foreign or American born, as it did in our hearts when we went to work in a strange place.

Some employment agents go still further, and during the process of hiring a worker give him a movie show picturing the complete operation of the plant—taking it from the receipt of the raw material, through the various manufacturing processes, on through shipping, just as general as it may be or just as complete as it may be in the space of time available, and increasingly that time available is lengthening.

We used to brag in employment management about hiring a man in a minute, or half a minute, or in a number of seconds, or about the number we could put to work in a year. But that has changed; now we are beginning to boast of taking an hour and a half, and even a week and a half to put a man properly on his job.

Now, it doesn't need anything more than an appreciation of that contrast to bring to your mind how well sold a man may be on his job, how much he may be made to feel that he is a constructive part of that establishment, if he is put to work by the modern method, as contrasted with the former. If when he is put on the job the foreman calls his attention to the movie pictures of the particular operation that he is engaged in, and if it only be wheeling cinders away from the central boiler plant—if he is told at the time that that is the central boiler plant that furnishes the power to run the plant that does the things that he saw in the movies and that these cinders are the refuse from the boiler that generates all that power—then and there he links himself to the plant as a constructive force, as an important part of that machine, and that is very necessary if we are going to settle this unrest that we now feel.

The unrest in industry today is evidence of a social, a political unrest that must be met freely and frankly and squarely and corrected. In fact, it is manifested as Bolshevism in its ultra-radical form. It is no less than that. Probably when the history of the Bolshevik movement in Russia is finally written, and we know just what its causes were, it may be found that a large contributing cause was the fact that the citizens of that country had no part whatever in their government. Things were done *at* them and *for* them, but never *by* them. They were never taken "in on the know."

And while it is possible that their condition as citizens of that country under despotism was as good, their living conditions and all other conditions just as fine as they themselves might have done through democracy, they never had that feeling because they had not been consulted. It is simply a statement of basic psychology to say that we are only mildly interested in the things that other people are doing for us, but we are intensely interested in the things that we are doing for ourselves.

Going just a little further, if we have seen, as in the safety movement, the efficiency that may be gained through consulting the workmen themselves on such a matter of common interest, isn't it perfectly logical to go to the men themselves for consultation on other problems of mutual interest—recreation, sanitation, health, and then the controversial matters of hours and wages?

It has been stated by Professor Hoxie that naturally the aims and purposes of employee and employer are antagonistic; that the employer seeks long hours and low wages as a means to a low cost of output, and that conversely the employee is constantly seeking shorter hours and higher wages, which must necessarily mean a decreased output.

There is abundant experience in the industrial world today to show that the reduction from twelve hours to ten hours in the length of time employees are working has not decreased production—that the reduction from ten to eight hours has been accomplished in factories without any decrease in the output, and that today reductions are being made from nine to eight hours without any decrease in the output. Shorter hours do not necessarily mean reduced output. Neither do higher wages necessarily mean increased cost, if they mean a higher standard of living, a better mental and physical development. I firmly believe that there is a common ground upon which employer and employee can meet for the consideration of their problem, and it need not be a controversial affair either in the consideration of wages and hours any more than any consideration of safety or health or recreation or plant canteens or anything of the kind.

The International Harvester Company's Plan of Employee Representation

Our plan is known as the Harvester Industrial Council plan of employee representation, and was offered to the employees of the company on March 12 of this year. It was a frank invitation to them to participate in the determination of the policy of the company on all matters of mutual interest, including wages and hours, on an equal basis. They were invited to elect, by secret ballot, one-half of the membership of a works council whose function was to determine the policy of the company on the various items I have enumerated. The management appointed the other half of the membership. A guarantee of equal participation was had by the adoption of a unit ballot system. There are only two ballots cast. A majority of the employees' section determines their attitude and casts a unit ballot, as also does the majority of the management representatives.

These unit ballots have the same value, regardless of the number present on each side. The employees are guaranteed the right to a free performance and a free action in all of their activities as employee representatives. If there is any question of discrimination on their part, they may appeal directly to the president, and if not satisfied with his adjudication of the matter, it may then be arbitrated upon the selection of an arbitrator, mutually agreeable, whose decision would be binding upon both parties.

The plan was not put into effect at any plant which did not vote by considerable majority for it. It was first offered at the seventeen American and three Canadian plants. It was adopted at seventeen and failed of adoption at three. The day after the failure to adopt at these three plants petitions were circulated asking for another ballot and an opportunity of coming under the plan. The statement was made that the employees did not fully understand the plan on the previous day because it was written only in English. We have since published it in foreign languages because the employee representatives find it exceedingly difficult to convince foreign-born employees of the exact meaning of a certain clause if they themselves have to translate it.

We also made an error in the form of ballot. We use a ballot

stating "For adoption. Against adoption." We had some very good friends on the outside of the plant who were working against that plan and they told many employees, many foreigners, to vote on the bottom line, and when they saw the phrase "Against adoption" it did not mean anything to them and they voted according to instructions on the bottom line.

There was no positive effort on the part of the company to "sell" the plan. It was simply a dignified announcement. Each employee was furnished with a copy of the plan with a short résumé of a facsimile of the ballot, and asked to indicate, after three days of consideration, his wish for or against it. At the present time we are operating in nineteen of the twenty plants of the Harvester Company under this plan.

Another fundamental included in the plan is the guarantee of the protection of the employee against any discrimination because of race or sex or membership in any religious body or labor organization.

FUNCTION OF THE WORKS COUNCIL

The function of the works council is limited to the determination of the policy of the company with reference to wages, hours, recreation, health, sanitation, restaurants, and other matters of mutual interest. A policy having been determined, its execution lies wholly with the management. But the manner of execution being open to question at any time, it may be brought up through the works council. In other words, we have given to the employees equality in participation in the legislative and judicial functions, but not with reference to the executive. That, we believe, still lies wholly with the superintendent and foreman, and it is further accented in the procedure in bringing matters before the works council.

The plan states that any employee desiring to bring a matter before the works council shall present it first to the secretary, who shall ascertain whether it has been presented to the superintendent through the regular channels. If this has not been done, he shall see that it is done promptly. If the adjudication of the matter by the superintendent is not satisfactory to the employee or employee representatives, it then and then only comes before the works council. It must be presented in writing by the secretary to all members of the council at least three days before a regular meeting. The decision of the works council is final and binding.

When it agrees upon a matter—and it can only function through an agreement because the two ballots cast in opposition to each other completely deadlock the decision of the works council—it is forwarded to the superintendent for execution. In case the council deadlocks, it is then in order to reopen a discussion or propose an alternative or compromise resolution. If the deadlock still continues the matter is then referred to the president of the company, the highest executive officer, who is given ten days in which to propose a settlement acceptable to the majority of the employee representatives.

THE GENERAL COUNCIL

If he fails to do that within the following five days he may elect to put it into arbitration direct, and arbitration is by mutual consent before a disinterested and non-partisan arbitrator, if one can be chosen. If not, each side selects one. If they agree, the matter is settled and their decision is binding and retroactive. If they cannot agree and choose a third arbitrator, a majority of the three is binding on both parties; or the president may elect to throw it before a general council—provisions being made that by such a reference, or in the event that a matter is introduced into a works council which is common to more than one other plant, the president may indicate the other plants which are interested, and call a general council of those plants, whereupon the works council originating the proposition ceases its consideration of the matter.

In a general council the employee representatives of each of the plants designated by the president send at least two of their representatives. For a general council they select one for each thousand employees or a major fraction thereof, but in no case less than two. The president names a number of management representatives, not greater than the total of employee representatives, and they function then exactly as the works council in regard to the method of ballot, etc.

Provision is made that either council may be recessed at any time and the employee representatives and management employees be privileged to withdraw and canvass their action. In a general council a recess may be taken to enable the plant representatives to consult with the other members of their works council. And provision is made, in order to do this, that the superintendent shall convene the works council in whole or any part of the employee representatives for conference with the representatives who have been elected to the general council. Their traveling, hotel and other expenses are paid while in the performance of this work.

After consultation with their plants upon a matter pending the general council may be reconvened, and decision is then binding upon all plants affected. Provision is made that all employees serving on the works councils shall be paid for the time they are so serving. They are privileged to call before them any employee of the plant to give testimony in a case under consideration, and the time of the employee so summoned is paid.

Provision is made, however, that in case it is not acceptable to the employee representatives to receive their money from the company, they are at liberty to arrange for a pro rata assessment of the employees directly. That was because of the objection which had been made by organized labor and other students of the subject to the general plan of paying employee representatives while serving as such.

Copies of the plan are available, and no less than 658 specific requests for them have come from other industrial establishments, from colleges and universities, from individuals, and from various sources.

RESULTS ACCOMPLISHED BY WORKS COUNCILS

We have been most agreeably surprised at the splendid results accomplished through these works councils since March 12, but surprised only at the rapidity with which they were accomplished, because there was no question in our minds as to what we would ultimately get.

There were elected by the employees 148 representatives in the 19 different plants. The average age of those employees is 38 years and 10 months. They are mature. A hundred and twenty-seven of them are married, and only 21 are single. Their average length of service is 7 years and 7 months, so they are relatively old-timers and mostly sedate married men. A hundred and two of them are native-born Americans, and 46 are foreign-born naturalized citizens.

Ninety-seven per cent of all of the employees who were present and eligible actually voted for or against the plan when it was proposed for adoption. The results at the various plants ranged from an almost unanimous vote for it to a vote of sixty to forty against it in two of the plants. One or two of the plants showed only a scant majority for the plan, considering the number of men involved, and we were somewhat puzzled at the time as to just what the result would be. For instance, at one plant the majority on the whole plan was only 200, and in one particular department—we will say the malleable foundry—the vote was 265 against the plan and 125 for it. And we thought that those 125 should be the only ones who would participate in the subsequent nominations and election, and we might then have a condition where only 65 of them would elect a representative for practically 400 men, which we could not feel was true representation. We were very much relieved, however, to learn that 98 per cent of all of the employees present and eligible actually voted at the nominations.

In the department just mentioned every man working on that day—nearly 400 of them—participated in the nominations, and again in the elections. On the final ballot for elections a nominating ballot was provided first in order that the elective representative might have at least a majority vote of his con-

stituents. It can easily be seen that if we had a department of 300 men and only one elective ballot and there were, say, 30 candidates running pretty evenly, possibly a man with only 25 or 30 votes would win the election. The nominating ballot makes it sure that at least a majority will be had by the successful candidate.

The average vote cast for the successful candidates at all plants was 68 per cent of the total, so that the winning candidates represented, or were elected, by more than two-thirds of their constituents. With a single exception, every local plant superintendent has written in response to an inquiry that if he had been permitted to select the employee representatives he would not have been able to choose a more satisfactory and more truly representative group than did the employees by their own secret ballot.

The Harvester Company has always operated under the open-shop principle, but a number of union men have been elected as employee representatives and are serving on works councils. Our experience shows that these men appreciate as readily as non-union employees the constructive possibilities of the plan and there is no indication that their participation in the co-operative activities of the council is not fully as satisfactory as that of the non-union representatives.

One of the first results under the plan was, naturally enough, a demand at several of the plants for shorter hours and increased wages. As one old-timer said, it looked very much as if the company was giving a sort of a Christmas party when it passed around those booklets saying that the works council would determine wages and hours.

With a single exception these requests were withdrawn voluntarily by the employee representatives upon presentation of the management's side of the case, which was to the effect that this was not an opportune time for such action—that the agricultural-implement business was a competitive industry. We were able to show that our wages and our rates were as high or higher than in similar industries in our own vicinity, and that only through constructive work in this council, through a greater efficiency in the reduction of the costs, would we be enabled to pay higher wages and still remain in a competitive market; and if they were willing to do their part we would do our part and exchange figures with them and show exactly what conditions were at any time, and when they felt that the time had come when we had better consider it again, we would do so.

In our experience thus far under the "Harvester Industrial Council" plan the works councils have been able to reach mutually satisfactory conclusions on all matters proposed with a single exception. That exception was in reference to a demand for a wages and hours revision, affecting about 25 per cent of the employees of one of the plants. The proposition as put up by the employee representatives did not meet the approval of the local management. After an extended discussion that was wholly friendly and frank, the ballot of the works council resulted in a tie. This was probably due to "an agreement to disagree," because both sides felt that the matter was one which could well be referred to the president for settlement and were entirely willing that this course should be followed.

Automatically the matter came before the president who was able to make a compromise offer to the employee representatives which met with their entire approval and at a special meeting, held four days after the original action had been taken in the works council, the proposal of the president had received the unanimous approval of the employee representatives and the matter was settled to the satisfaction of all concerned. In fact, it has resulted in a marked advance in the morale of the plant and the friendly attitude of the employees toward the council is doubtless more firmly established by the manner in which this matter was handled.

Probably 75 per cent of the actual business of the works council is translated outside of the regular meetings. Many suggestions or complaints have been brought to the attention of employee representatives and referred by them direct to the foreman or superintendent, who have promptly cared for the matter to the complete satisfaction of all concerned. This has been particularly true with reference to correction of ventilating equipment, improvement of shop practice, more convenient time of the weekly payday, occasional reviews of piece work rates and similar matters. This functioning of the council has been of especial value in acquainting the employees with the principles of time and motion studies, the reasons for adoption of certain shop rules, etc.

The employees have universally seemed appreciative of the opportunity to familiarize themselves with the facts as to any situation and have been exceptionally fair in passing judgment after complete discussion. They have displayed particular interest in production problems and seem to realize that the basis of larger returns to them for their labor lies in an increased production and more efficient operation of the shops.

Some of our plants are in the middle west side of Chicago, right in the heart of the radical district. Another in particular is out on the far south side, where probably you have read of race riots in Gary and Indiana Harbor and that vicinity.

I believe firmly that there is a well-organized propaganda on foot to start Soviet organizations in this country, and to play up the rebellious spirit in the foreign element in the vicinity of some of our shops.

The foreign members of one of our works councils desiring to meet this movement, asked for information which enabled them to get up a report showing the participation of the foreign-born employees in military service of this country. They drew parallel columns of the number of foreign-born employees per thousand of the men at the plant; and the number of each nationality per thousand who engaged in the military program. The average for the whole plant, of all the employees engaged who went into military service was 22 per cent. It was much higher at the other plants. The average of all the foreigners was 22.2 per cent, practically the same, but particularly the average of the Polish people against whom sentiment had been directed, and against whom a definite campaign was being waged in playing up their racial spirit, was 36 per cent.

The average participation of the Poles was greater than that of the Americans. And then they drew some conclusions: that the foreigner, while he was not a citizen, and therefore not bound by the same ties as the American, had contributed almost the same to the military program, and individual nationalities to a greater extent than had the Americans; that his contribution had really been much greater from the fact that he was not a citizen, not bound by those ties; and they drew the conclusion that the anti-foreign sentiment which was being engendered was all wrong and not justified by facts.

Now, that was done in the works council committee on publicity without any instigation by the management whatsoever. It was the thought of the men themselves as to how they might compete with this insidious and destructive propaganda.

Responsibilities Undertaken by Works Councils

We had a restaurant which was not very satisfactory. It was losing money for us and not getting the results which we wanted. We turned it over to the works council and the patronage has trebled since that time. It no longer shows a deficit. It was frankly and freely turned over to the men to manage. They hire their own manager, they make their own rules, they set their own prices, and they have learned something about the restaurant business that we wanted them to know, and something of its trials and tribulations, and we have "sold" the proposition entirely.

We have had one or two requests for reinstatement of discharged employees. We have functionalized employment bureaus and all recommendations for men on the part of foremen are reviewed at the employment office. There are no restrictions in our plan as to what may come before the works council. In two cases—the only cases thus far that have been presented—the works council by unanimous vote upheld the decision of the employment manager and refused to reinstate the employee who thought he had a just grievance.

The safety program has been rejuvenated. We thought we

were getting up efficient bulletins and we thought we were carrying our message all the way down the line. We thought that our safety program was satisfactory, and we couldn't go much farther with it. Since the inauguration of the works council, however, our accident-frequency rate has steadily fallen month by month. The character of the bulletins has changed somewhat. They are written in shop parlance, and by the men on the safety committees.

The sub-committee organization activities of the works council have been wonderfully well arranged by the employees themselves without any action of the management. They have unanimously said that they do not want a grievance committee. They do not want any committee on wages and hours. Those are subjects that they want to come out for a full discussion in the works council, and their reasoning was somewhat along these lines: They said, "If we had a grievance committee which only went to the boss on controversial matters, he couldn't help but get down on us a little bit, and believe that we never think of anything except how to make trouble. And we don't want to have that put up to just one or two men, we want the whole council to work on that; and then, too, we have this feeling that if a man comes to us with a grievance or a request for piece-work revision, or revision of prices or hours, we don't ourselves want to say to him, 'Well, you go over in the blacksmith department and see John Doe, because he is on that committee. We don't want to have anything to do with that.' Those are things they want us to get into, and if we do, we want to do it to our complete satisfaction."

The sub-committee activities, so far as grievances and hours and wages have been concerned, are always taken up by the council as a whole, and it has meant that no one or two individuals sat themselves up as business agents in the plant.

The question has been asked how much of this human relations problems lies within the field of the mechanical engineer. Engineering, to my mind, has been the consideration of an exact science, and these matters of personnel in the industrial sense are not reducible to stable factors at all. In the whole scale of industrial relations we are always dealing with the human being—a body with a mind, a creative force, and a soul, and therefore not reducible to any sort of stability as regards its valuation. You can't get up any sort of a formula which will solve a given condition, and repeat on it. And I don't believe the personnel problem ever should be treated as a science and coldly analyzed or formulated.

I believe that its direction and its constant progress should be made by men, not necessarily technical in their education, although we do need the assistance of every bit of science that can be brought to bear, but more particularly men who are given over to the idea of real service.

There are many employment managers functioning today in splendidly furnished, mahogany-lined offices, and who receive the requisitions from foremen for help and who analyze the jobs' specifications quite technically, and select by means of phrenology, and goodness knows how many other "ologies," applicants from the waiting line, if there is such a thing, or by scientific advertising, if the waiting line is not there, and possibly fill those jobs.

But I believe the work is best done by men who forsake the office and don't hire through an employment window but get out and interview a man across a desk, and look upon him as another human being, one who is coming into a strange land, into a strange company, and make him thoroughly at ease; who will sell him his job as a constituent part of a great assembly, who will look after him, not in an apparently disinterested way, but in an atmosphere of good-fellowship after he goes to work, and who will look upon his problems with a light of experience and know exactly, or nearly exactly, what his thoughts are, what his suspicions are—and those I do not think can be had by a science as well as by experience.

I think the employment engineer of today—the personnel manager of today—should first of all be chosen on personality. That is certainly more than fifty per cent of the necessary make-up. He should be of an engaging personality, a man who can converse with other men and get them in turn to converse with him; who has a sympathetic ear; who has a certain poise; and withal, who is a good, keen judge of human nature. And then on top of that, as much technical training as he may have.

The direction of the movement lies with all of us, for back of it all is this industrial unrest, a manifestation of political and social unrest, and it concerns every one of us as citizens that American industry shall do business on the square, that the structure of American industry shall be fundamentally sound, and that the correction of any improper practice and wages and accidents and conditions may be had through the instrumentality of collective bargaining and simply changing the conditions themselves that are causing the unrest, rather than by completely overthrowing the structure.

It is then, I believe, that we will have exercised an important reaction upon the community as a whole, and that that reaction will be manifest in keeping from our shores this menace of Bolshevism which now looms black on our horizon.

MOTOR GASOLINE

INFORMATION regarding the desirable properties of gasoline and the best methods of testing it are contained in the Bureau of Mines Technical Paper 214, written by E. W. Dean.

The desirable properties of gasoline are summarized as follows:

1 The gasoline should not contain too large a percentage of highly volatile products, which tend to cause large evaporation losses and excessive danger in handling and storage, but should have enough volatile constituents to permit starting an engine under reasonably unfavorable conditions, without preheating.

2 The gasoline should not contain any considerable percentages of heavy or non-volatile constituents, which after atomization into the engine cylinders cannot be completely vaporized and burned.

3 The gasoline should not contain material that after combustion leaves a residue that collects in the motor.

4 The gasoline should be free from substances that attack metal, either before or after combustion. Unremoved acid (used in refining) falls under this head.

5 Neither the gasoline nor its products of combustion should have a strong or markedly disagreeable odor, as this is objectionable to users of automobiles.

6 The gasoline should be free from non-combustible material such as water and sediment.

As already stated, the Bureau does not believe that one set of specifications is satisfactory for all needs. The following system is suggested, however, as a simple and satisfactory scheme for regulating the quality of ordinary automobile gasoline:

Color. Water-white—to be determined by inspection of the vertical column in a 4-oz. sample bottle or 100-cc. graduate.

Acidity. Total absence of free or combined acid—to be determined by testing with any satisfactory indicator, the water extract obtained by shaking thoroughly with 1 cc. of distilled water the residue in the flask after completion of an analytical distillation.

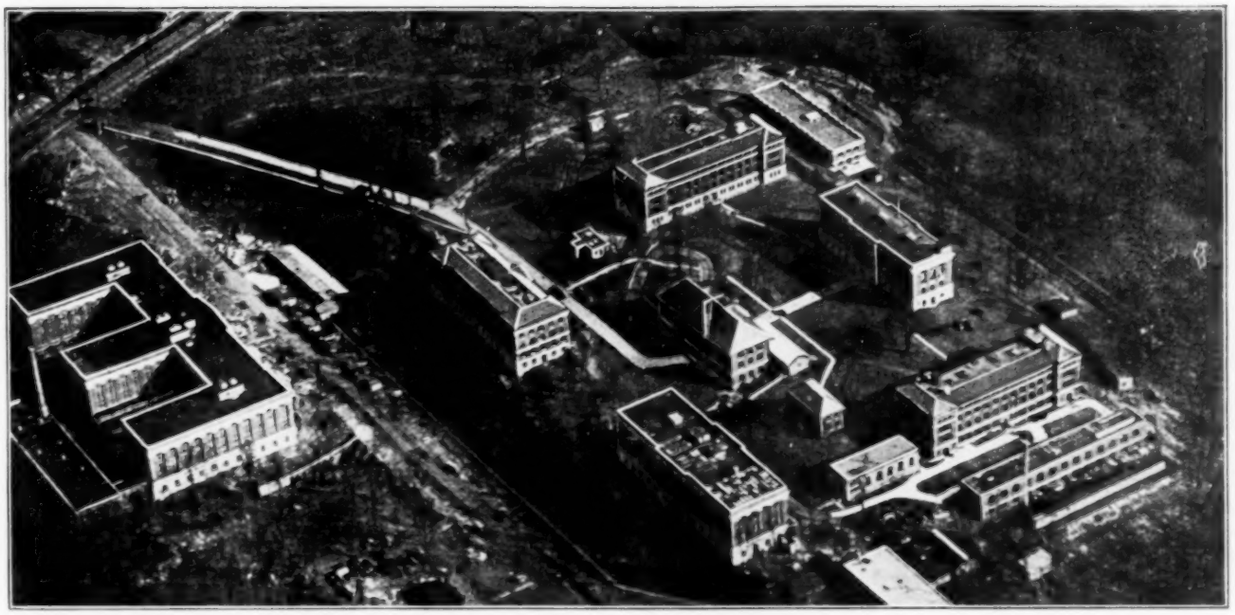
Volatility. The Bureau recommends a method of distillation similar to that adopted by Sub-Committee XI of Committee D1 of the American Society for Testing Materials (see A. S. T. M. Yearbook for 1915, pp. 568-569), the only two noticeable points of variation being the manner of reading temperatures against fixed percentage points and the use of a thermometer of lower range. The requirements for volatility are that when gasoline has been distilled by the bureau's method it should meet the following requirements:

a The temperature read on the thermometer when 20 per cent has distilled should not be below 70 deg. cent. (158 deg. fahr.), nor above whatever limit is fixed after due consideration of conditions of use.

b The temperature read when 90 per cent has distilled shall not be above another limit similarly chosen.

c The temperature read when 50 per cent has distilled shall not be higher than a mark halfway between the upper 20 per cent limit and the 90 per cent limit.

d The dry point shall not exceed the 90 per cent limit by more than 40 deg. cent. (72 deg. fahr.).



Bureau of Standards, Washington, D. C., Taken From an Airplane

Condition of Research in the United States

By ARTHUR M. GREENE,[1] JR., TROY, N. Y.

This paper, by the Chairman of the Research Committee of the A.S.M.E., deals with the conditions under which research is now being carried on in the United States. The author first discusses research in its relation to the technical school and engineering experiment stations. Cooperative research and the research activities of the Government are next presented and finally the author considers commercial and industrial research work. The complete paper contains lists of the educational institutions having mechanical engineering laboratories, of the private research laboratories and of manufacturing companies having their own research facilities.

HISTORY records the development of science from fortuitous observations and from systematic, careful and exhaustive research. The work of the Greeks as shown by Lucretius on the constitution of matter could only have been made after a careful and exhaustive study of the laws of nature. The work of Hippocrates certainly indicates a previous study of anatomy and the action of certain drugs. The studies of Galileo and Newton, of Kepler and Herschel, of Watt and Stephenson, tell of careful thought applied to the interpretation of facts which led to the establishment of laws. The story of Berzelius and his kitchen laboratory illustrates the spirit of adventure into the unknown which brought to us our early quantitative knowledge of the elements. The accidental observations of Galvani, Newton, Bell and Crookes by future development and study led to results of incalculable value to science, while the theoretical studies of Kepler, Maxwell and Hertz predicted results which in giving confirmation to theory gave also confirmation to the correctness of experimental observations.

Although all past ages have had men devoted to research, they are not numerous in any one period. If there is one thing, however, that marks the present epoch, it is the prevalence of this idea. In the past, research was carried on by the few, but today as a result of education and as a result of the success of research in many fields one can scarcely read a periodical of any branch of science without finding some article on this subject. For the last fifty years the commercial value of research has become more and more evident to industrial plants. This appreciation has been coincident with the growth of these plants and has made their development possible, while reciprocally the growth of the plants has made extensive research possible.

For many years our colleges and universities have had their laboratories where some research has been done, and with the development of our industries following the Civil War the necessity of commercial laboratories for examining or controlling products was evident. The search for knowledge by some of the investigators and the possibility of application of the results of their researchers undoubtedly reacted, so that the laboratories of examination and control became laboratories for investigations in new and unknown fields.

Research work, quite general before the present war, became more extensive in overcoming the dastardly appliances of the Hun in devising new apparatus, products and manufacturing methods and in improving quality and production. The war has demonstrated, if demonstration was necessary, the value of research, and it is now the opinion of most of us that this stimulating viewpoint should not be lost and that the war-time interest should be continued.

Before discussing the matter of the physical condition of the various laboratories there are a few general considerations which should be mentioned. The cost of research in the past has been such that in many cases it could only be undertaken in an extensive way by large corporations. The necessity and value have been evident but the small plant has been unable to inaugurate that which it has known to be of value. In other instances there have been investigations which have been of such a nature that there would be no commercial gain from their results, although of great use to mankind. The necessity of such work has been clearly seen and appreciated by some, and in this country institutions and foundations have been established by public-spirited citizens to carry on investigations or to give grants to those who are

[1] Professor of Mechanical Engineering, Rensselaer Polytechnic Institute. Mem. Am. Soc. M. E.

Presented at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

working on problems for the general good. The reference is to such organizations as the Rockefeller Institute for Medical Research, the Carnegie Institution of Washington, and the Sage Foundation.

A number of private commercial laboratories have been undertaking commissions for clients, but recently the plan worked out years ago by the Associated Factory Mutual Fire Insurance Companies of New England in their coöperative laboratory and the Insurance Engineering Experiment Station has been applied in the coöperative work of certain industries. These investigations have been undertaken by an industry as a whole or by group of manufacturers, and the results have been distributed among the contributors to the expense funds, or, in certain cases, the results of the experiments have been freely given to the world.

Research in Technical-School Laboratories

To turn now to the present research activities, let us consider first our universities and technical schools. The general equipment of the university laboratories is planned to give training to the undergraduate in methods and to illustrate certain laws. The engineering laboratories are equipped so that research work is possible, but in many cases the schedule for instruction work is so heavy that little or no research work can be done. Nevertheless, under these adverse conditions some work of great value has been produced during the last thirty years in the technical schools by faculty members, graduate students and even by undergraduates. The lack of time for experimentation has been cared for in the engineering experiment stations by the employment of full- or part-time investigators. In this way work can be carried on continuously to a conclusion. At present the disorganization of these laboratories by war activities has caused most of the work to cease. A return to normal conditions, however, is looked for within a year. The laboratories of chemistry, physics, biology and the other sciences have been doing much graduate research work. This has been of a theoretical nature rather than of the applied form of research more evident in our engineering laboratories. The small number of graduate students of engineering has partially accounted for the limited amount of research from the engineering schools.

The equipment of these technical schools is usually quite diversified and adapted for research work of a varied nature. The equipment has been planned in many cases for certain problems and in some instances contributions have been made by some associated industries for equipment to make investigations of problems of that industry. Thus, at Johns Hopkins University the gas interests in and around Baltimore donated a fund for the equipment of a laboratory to study gas manufacture and its by-products. At the Carnegie Institute of Technology at Pittsburgh a laboratory for rolling-mill research and instruction is being established from funds which are contributed by a number of steel manufacturers.[1]

One of the great needs of the present time as voiced by directors of a large Government laboratory and of a large commercial laboratory is the need for more research men. Research demands a man of clear vision, great imagination, tremendous resources, absolute honesty, good training and devotion to work. The love of the work will have to be the incentive as in many cases the monetary returns are small. If our colleges of engineering and science could by some means instill into more men the great desire for discovery through research, they would aid much in the contributions of this age to the future. Training is also necessary, and that should be done by men engaged in research.

Engineering Experiment Stations

To aid the work of research for the industries and manufacturers by supporting men on whole or part time to carry out investigations, engineering experiment stations have been established in many state universities. These have been active and the development of such institutions is considered by some to be of such national importance that several bills have been introduced in Congress for Government aid in establishing them throughout the United States.

The Engineering Experiment Station of the University of Illinois, organized in 1903, usually comes to mind when discussing this question, although there are fourteen such stations at other state universities. The Engineering Experiment Station of the University of Illinois up to January, 1919, has issued 110 bulletins and 10 circulars on its researches. Twenty-eight of these deal with structural problems, 28 with problems relating to fuel, its mining, storing, combustion and analysis, 10 with problems of mechanics, strength of materials and machine design, 14 with heat problems and 11 with problems of electricity and electrochemistry. These papers are sent free of cost to interested parties in some cases, and in other cases a nominal charge is made.[2]

Coöperative Research

While discussing the subject of the experiment station, the possibility of the coöperative research as shown by present conditions and the different methods of solving this problem should be mentioned. The problems of hot-air furnace heating have been solved by empirical rules which have had little if any scientific foundation. An association of builders of hot-air furnaces has granted the Engineering Experiment Station of the University of Illinois certain funds of money to finance an investigation of these problems, the results of the investigation to be made public at its conclusion.

The problems of metal rolling are complex and have been studied in the past with difficulty because investigations must not interfere with production. The coöperative plan of equipping a full-size rolling mill at the Carnegie Institute of Technology equipped with special apparatus for varying conditions and making quantitative determination of different data exemplifies what is being done by another industry.

The Mellon Institute of Research of the University of Pittsburgh is unique and illustrates a development of research by funds contributed to a laboratory by individuals, corporations or industries for the solution of problems confronting them. The Institute was organized about thirteen years ago by Dr. Robert Kennedy Duncan, and the contribution of funds for the support of the research was continued by each contributor for one or more years. The money so received served to pay the salary of the man or men on a special piece of research work and to pay for very special apparatus. The Institute houses the research, furnishes ordinary supplies and apparatus, affords library and consultation facilities and directs the work. The investigations are made for the donor and the results belong to him. At present the work is under the charge of a director, acting through two assistant directors in charge of the fellows on individual and multiple fellowships. In the Institute a method of developing complete unit experimental plants to study processes for certain donors has been used. In this way commercial processes have been developed from laboratory research in a way not done in many other research laboratories.

A list of coöperative efforts in research must mention the work of the laboratories of the Factory Mutual Fire Insurance Companies. The work of this association has covered many years, some of its bulletins being issued over thirty years ago. Many papers and discussions were contributed to the early TRANSACTIONS of this Society from its staff.

Government Activities in Research

The Bureau of Standards at Washington and Pittsburgh, the laboratory of the United States Geological Survey at Pittsburgh, the Food Laboratory and Forest Products Laboratory of the Department of Agriculture and the Naval Experiment Station at Annapolis, are a few of the Government activities interested in research.

[1] A list of 78 educational institutions having mechanical engineering laboratories is given in the complete paper.

[2] A list of 14 universities having engineering experiment stations is given in the complete paper.

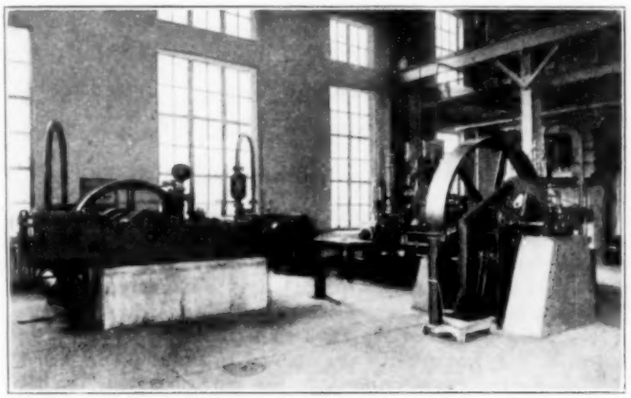
At the Bureau of Standards research work is being done in physics, chemistry, metallurgy, manufacturing and engineering. There is hardly a branch of human endeavor which is not touched by this enormous research laboratory. In 1917-1918 there were over 1400 employees connected with the Bureau, and accounts aggregating more than $3,400,000 were handled. During this year the Bureau issued fifty-three publications, and these may be obtained through correspondence.

The primary work of the Bureau is the definition and fixing of standards of measurements, standard constants, standards of quality, standards of performance and standards of practice, and to do this they have divided the scientific and technical staff into a division of weights and measures, a division of heat and thermometry, an electrical division, an optical division, a chemical division, a materials division, an engineering research division, a metallurgical division, and a ceramic division. Each division is under a Chief of Division, and under him there are numerous experts and assistants. The Bureau feels that its function is one of service to the nation, and it endeavors to aid all who apply for information or guidance.

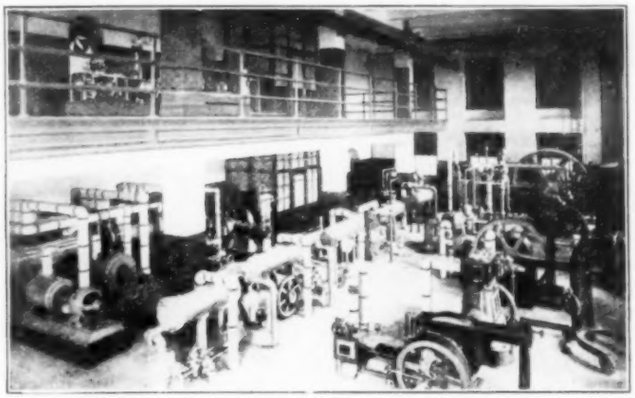
The work of the Gage Section of the Bureau of Standards during the recent war activities must be remembered as of the greatest importance. This department undertook to regulate the gages used in the various manufacturing plants through its headquarters in Washington and its branches in the East and the Middle West. The Section has developed instruments for testing screw-thread gages for profile and pitch, instruments for end measurements, and, in fact, it is prepared to test any commercial gage or templet for accuracy. The Section has studied the salvaging of gages and is vitally interested in the problems of duplicate production.

The activities of the laboratories of the Geological Survey and the Department of Agriculture are devoted to their special fields of endeavor, and in each case scientists of training and experience are in charge of the research.

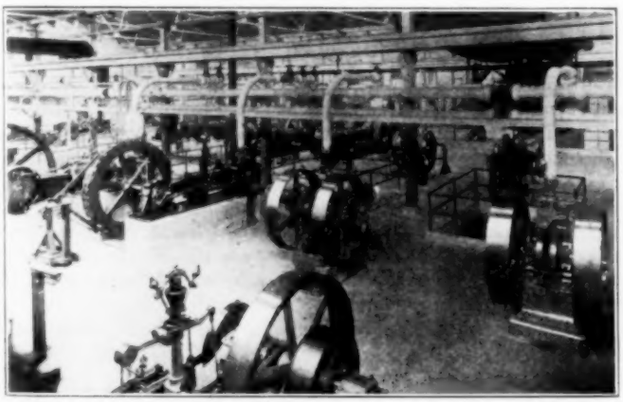
The U. S. Naval Experiment Station at Annapolis, Md., is used to study the apparatus and materials used by the U. S. Navy or certain Government bureaus. The work consists in making tests on these, and in addition researches regarding the general laws underlying the apparatus have been undertaken. The Station is well equipped with apparatus and an excellent staff. The work of the Station is for Government information, but frequent papers by members of the staff appear at times before various technical societies.



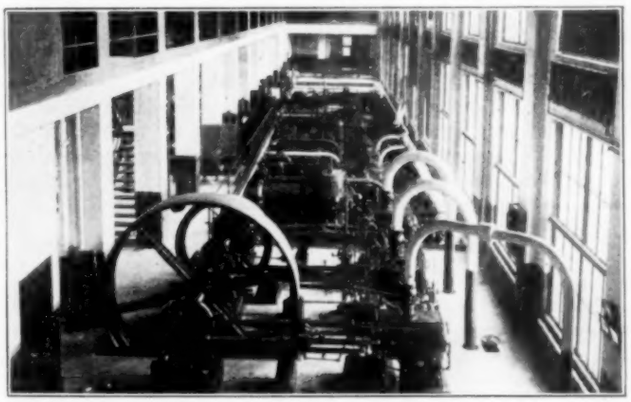
JOHNS HOPKINS UNIVERSITY



RENSSELAER POLYTECHNIC INSTITUTE



UNIVERSITY OF ILLINOIS



MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MECHANICAL ENGINEERING LABORATORIES OF TECHNICAL SCHOOLS

The Forest Products Laboratory of the United States Department of Agriculture at Madison, Wis., is devoted to problems relating to the applications of forest products.

The Watertown Arsenal is equipped for research in materials of engineering. The reports from this laboratory have been for years the source of many data on the strength of materials. The Philadelphia Navy Yard is equipped for research in fuel oils, while the Washington Navy Yard is equipped for testing ship models, propellers, airplanes and air propellers. The wind tunnels and testing basin are of special merit.

The research activities of the American Society of Heating and Ventilating Engineers in connection with the Pittsburgh Laboratory of the United States Geological Survey is important and illustrates the activities of certain groups of scientists and engineers. This society plans to make researches regarding problems arising in its field of endeavor for the benefit of the profession and the public. In this project the expenditure of $20,000 per year for a number of years is proposed.

LABORATORY OF THE GENERAL ELECTRIC COMPANY

LABORATORY OF THE PENNSYLVANIA RAILROAD

COMMERCIAL RESEARCH

The private research laboratories of the country are primarily devoted to investigations of materials for commercial purposes, to check products or raw materials or to improve the product. These are quite numerous, and the list of laboratories given in the complete paper shows in a partial way the private research resources of our country. Much of the work done by these laboratories is of the nature of inspection, but in many of them the commissions undertaken for clients have been of a true research nature, in finding the cause of defects, the methods of improving product and in some cases planning actual production methods or processes. Many of these laboratories have been in existence for almost a half a century; others have been developed in the last decade from a local need for such institutions.

The work of these private laboratories covers all fields of investigations and new equipment is obtained in many cases for special investigations. In some cases a laboratory has been specializing in problems of a definite character and its equipment for this work is expensive and complete.

INDUSTRIAL RESEARCH

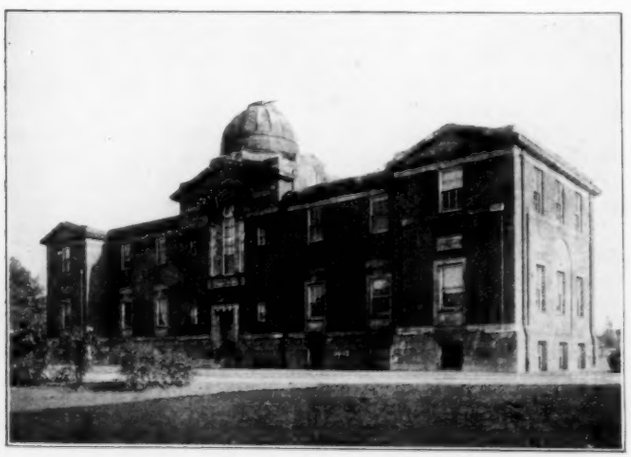
The last division of research activities is the one which undoubtedly represents the largest expenditure of money for operation, maintenance and equipment. It is the one including the various laboratories of the manufacturing plants of the country.

These laboratories occupy two fields, one the examination, inspection and testing of raw materials or finished products, in which the laboratory is called in many cases the test laboratory; the other concerned in determining physical and chemical properties and constants of materials, the investigation, development or invention of new methods, processes of manufacture, or even of products and the testing of these new schemes, in which case the laboratory is termed the research laboratory. In many instances the test laboratories are devoted to routine work, while in others researches of importance are carried out in the test department. In some organizations the laboratory combines both features under one head.

One of the oldest and largest of the laboratories of the corporations is that of the Pennsylvania Railroad at Altoona, Pa. It was established in 1874, and at present its staff of workers is over six hundred men, half of whom are engaged in inspection work. The expenses of this laboratory are about $500,000 per year, and the work of the department is the preparation of specifications for materials and supplies of the Pennsylvania System.

The locomotive testing plant, which was such a prominent part of the St. Louis Exposition, has been used at Altoona for further work in locomotive research. For studying problems on the road a dynamometer car is used by the laboratory. A unique part of their equipment is a laboratory car which may be sent to various parts of the system for the solution of local chemical problems or for other purposes.

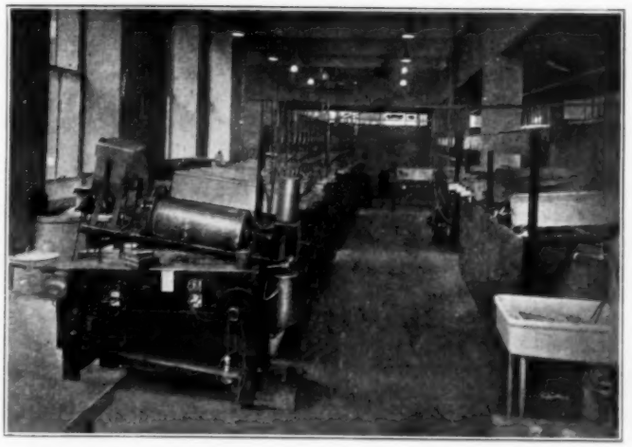
The laboratories of the Westinghouse Electric and Manufacturing Company at Pittsburgh, Pa., and of the General Electric Company at Pittsfield, Harrison, Cleveland, Lynn and Schenectady, represent the large laboratories of the manufacturers of electric apparatus. In both of these companies the main research



LABORATORY OF THE NATIONAL LAMP WORKS

LABORATORY OF ARTHUR D. LITTLE, INC.

PHYSICAL LABORATORY OF THE PENNSYLVANIA RAILROAD



SECTION OF THE GENERAL ELECTRIC LABORATORY

laboratories have forces of more than one hundred men, and the budget of each amounts to $500,000 per year.

In the Schenectady plant of the General Electric Company the department of tests is independent of the research laboratory. The research laboratory is devoted to problems of the development of new materials, processes and apparatus, and, as its name indicates, its work is of a research nature.

Work in pure science, which at the inception has no commercial aim in view, is one of the activities of this laboratory and the publications of its results in the transactions of scientific societies gives evidence of such work. The results of these investigations in some cases have led to results of great commercial value—as in the case of the gas-filled lamp, which had its origin in a research on the laws governing the loss of heat from small wires coupled with an investigation on the evaporation of tungsten.

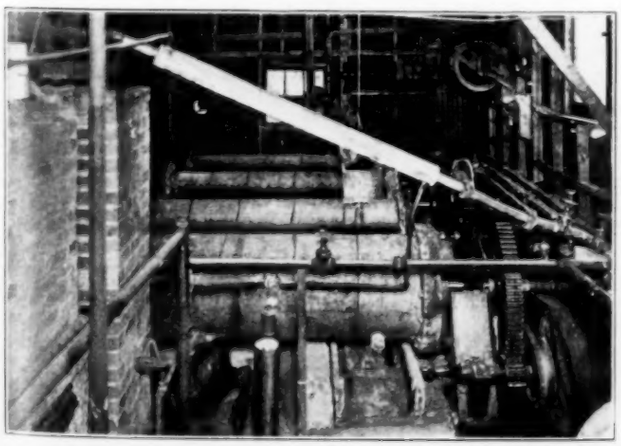
The research laboratory has as another of its functions the development of processes or of improved or new materials. The method of producing drawn tungsten wire, the production of insulating material, the improvement of transformer steel and the investigation of alloys represent certain of the problems of this laboratory. Here science has been applied for a definite commercial end. Another function of the laboratory is to make certain products for which there is but a limited demand. Thus the Coolidge X-ray tube, certain tungsten products and targets for X-ray tubes are manufactured in this laboratory.

The equipment of the laboratory is most complete for its activities. There are sixteen machines in its power plant giving power at different voltages and frequencies. Frequencies from 25 cycles to 2000 cycles may be had and by transformers voltages as high as 200,000 or currents of 12,000 amperes may be obtained. The building is piped with city water, river water, illuminating gas, high-pressure hydrogen, low-pressure hydrogen, oxygen, high-pressure steam, compressed air and vacuum suction and vacuum cleaning. Distilled water is supplied to any room by gravity, and liquid air may also be obtained. Various kinds of gas and electric vacuum and arc furnaces are installed in one part of the building. A furnace is installed for argon purification. Various crushers, grinders, rolls, punches and a 60-ton hydraulic press are installed.

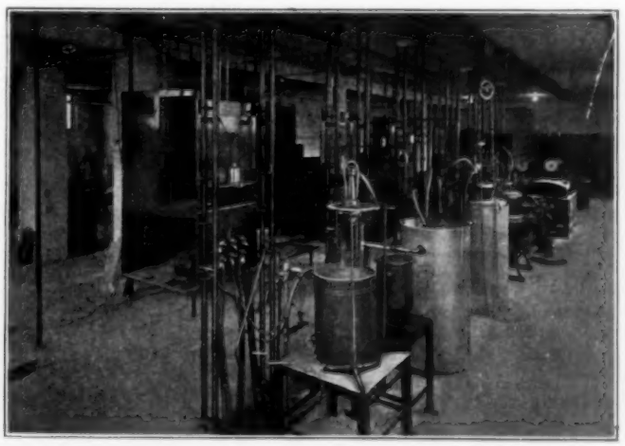
The illuminating laboratory, which is distinct from the research laboratory, is devoted to special problems in studying the best lighting units or methods of utilizing these units. The consulting engineering department laboratory, devoted to high-tension phenomena, the testing laboratory for materials, the standardization laboratory for instruments and the development of new instruments represent activities at Schenectady which are devoted to research in their commercial routine duties. Many engineering departments are constantly making investigations which are of a research nature.

The work at the laboratories at Lynn and Pittsfield is largely applied to the production problems of these plants, and at Harrison and Cleveland the problems of lamp production are studied. The problems of the Westinghouse Company are of a similar nature to those of the General Electric Company.

The research laboratory of the Eastman Kodak Company represents the research activity of another manufacturing corporation. The staff of this laboratory consists of about fifty men, some fifteen of whom are specialists. The budget amounts to more than $100,000. The work of the laboratory is devoted to physics, chemistry, to plant problems and new development. In



THE MELLON INSTITUTE'S EXPERIMENTAL PLANT FOR THE TREATMENT OF PHOSPHATE ROCK



METALLURGICAL LABORATORY OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY

this laboratory full-size apparatus is used at times in making research. As shown by the equipment of many laboratories, the study of complete processes in the laboratory on a commercial scale is one of the features of the times. The problems of this laboratory are organic, inorganic and colloidal chemistry, optics, color photography, film products and applications of general photography, chemical products and emulsions.

The laboratory of the National Lamp Association, now the Nela Park Laboratory at the National Lamp Works of the General Electric Company at Cleveland, Ohio, represents one of the best-known research institutions of this country. The research work of this laboratory is devoted to the physics, physiology and psychology of light, the production, utilization and efficiency of luminous energy. In this laboratory, with a staff of eight investigators of the highest ability directing the work, all kinds of illuminating problems are studied from every angle. The laboratory has a policy of sending out its experts to study local conditions, and in many cases investigators from other institutions come to this laboratory to carry on research. During the first eight years of its existence from 1908 the laboratory has produced 125 high-grade papers. These are abstracted by the authors and the abstracts published at intervals. In having abstracts made by the authors the important points of the researches are sure to be covered.

The great extent of research facilities is disclosed by the list of laboratories used by the Research Committee. This list, comprising ninety-four manufacturing companies having research laboratories, will be found in the complete paper.

Still another agency which not only has been of utmost importance during the present war, but also in its continuance in the times of peace, will have a still greater influence on the developments in science and industry is the National Research Council, the purpose and work of which is best explained by the following executive order issued by the President of the United States, May 11, 1918:

The National Research Council was organized in 1916 at the request of the President by the National Academy of Sciences, under its Congressional charter, as a measure of national preparedness. The work accomplished by the Council in organizing research and in securing cooperation of military and civilian agencies in the solution of military problems demonstrates its capacity for larger service. The National Academy of Sciences is therefore requested to perpetuate the National Research Council, the duties of which shall be as follows:

1. In general, to stimulate research in the mathematical, physical and biological sciences, and in the application of these sciences to engineering, agriculture, medicine and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.

2. To survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects.

3. To promote coöperation in research, at home and abroad, in order to secure concentration of effort, minimize duplication, and stimulate progress; but in all coöperative undertakings to give encouragement to individual initiative as fundamentally important to the advancement of science.

4. To serve as a means of bringing American and foreign investigators into active coöperation with the scientific and technical services of the War and Navy Departments and with those of the civil branches of the Government.

5. To direct the attention of scientific and technical investigators to the present importance of military and industrial problems in connection with the war, and to aid in the solution of these problems by organizing specific researches.

6. To gather and collate scientific and technical information at home and abroad, in coöperation with Governmental and other agencies and to render such information available to duly accredited persons.

Effective prosecution of the Council's work requires the cordial collaboration of the scientific and technical branches of the Government, both military and civil. To this end representatives of the Government, upon the nomination of the President of the National Academy of Sciences, will be designated by the President as members of the Council as heretofore, and the heads of the departments immediately concerned will continue to coöperate in every way that may be required.

The White House, (Signed) WOODROW WILSON.
May 11, 1918.

The National Research Council was under the chairmanship of Dr. George E. Hale, with three vice-chairmen, an executive secretary, a treasurer and two assistant secretaries. The executive board, under the chairmanship of Dr. John J. Carty, consisted of the officers of the Council, the chairman and vice-chairman of divisions and the chairman of sections of the General Relations Divisions, together with six elected members. The Divisions of the Council were as follows:

1 The Division of General Relations
2 Military Division with its Research Information Service
3 Division of Engineering
4 Division of Physics, Mathematics, Astronomy and Geophysics
5 Division of Chemistry and Chemical Technology
6 Division of Geology and Geography
7 Division of Medicine and Related Sciences
8 Division of Agriculture, Botany, Forestry, Zoölogy and Fisheries.

Each division was divided into committees and sections, covering special features of the work. There were over one hundred scientists representing various technical and scientific societies, educational institutions, commercial laboratories and manufacturers.

The work accomplished by the Council during the war has been so important and many of the investigations and researches which were not completed gave so much promise for the future that the Council has been reorganized to continue its work for the furtherance of science and its applications.

Warping of Aircraft Propellers

During the war one of the greatest troubles experienced with airplane propellers was caused by the warping and twisting of the blades near the tips, and a large percentage of the propellers received at the front were rejected on this account. In order to determine the causes and to develop methods of preventing this trouble, a number of experimental propellers were manufactured for the War and Navy Departments by the Forest Products Laboratory of the U. S. Forest Service at Madison, Wisconsin. The propellers were made of Central American and African mahogany using carefully selected stock uniform in density and moisture content, and were stored under uniform atmospheric conditions for 30 days between the roughing out and final carving operations. After the standard finish, consisting of five coats of spar varnish, had been applied, they were again stored under the same conditions for observation as to warping and twisting.

These propellers were made up and handled much more carefully than the commercial product, and every possible effort made to produce perfect results. After exposure to a very damp or humid atmosphere for three or four months, it was found that every propeller had warped or twisted or otherwise changed shape to an extent that made them unacceptable for use. They had all absorbed about five per cent of moisture through the five coats of spar varnish, and this moisture caused all the trouble. The treatments to which these propellers were exposed, namely, being manufactured in a relatively dry condition and later exposed to moist atmosphere, is very similar to that which is normally received by propellers made in the United States and shipped to France. Frequently propellers are made in a relatively moist climate and shipped to a drier one, and trouble from change of shape due to drying out is almost sure to result.

These changes may be prevented either by applying a moisture-proof coating or by keeping the propellers under uniform atmospheric conditions throughout their life. At present, the aluminum leaf coating developed by the Forest Products Laboratory is the only practicable moisture-proof coating which has been successfully applied to propellers. It is not possible to keep propellers under absolutely uniform atmospheric conditions during manufacture and service, but these conditions can be approached by making up the propellers at the moisture content which they will normally reach in service. Propellers made up this way and coated with aluminum leaf have the best possible chance of giving high efficiency and long service.—*Technical Notes, Forest Products Laboratory, U. S. Forest Service.*

Research Work on Malleable Iron

By ENRIQUE TOUCEDA,[1] ALBANY, N. Y.

This paper contains an account of four years of research work undertaken for the American Malleable Castings Association as a plea for industrial research among manufacturers and as a striking example of what such research can accomplish. The author outlines the organization and purpose of the Association and shows how the quality of the product of its members has steadily increased since the beginning of the research work. Malleable-iron castings, due to lack of uniformity and dependability, were rapidly being replaced by other materials. There were many fallacious ideas and theories regarding the physical properties of such castings and the methods of annealing them. Records of tests of 1-in. bars from seven different concerns made by the author in 1911 showed that the average ultimate strength was 39,882 lb. and the elongation under 5 per cent. A report dated March, 1919, to the members of the Association, each of whom regularly submits test bars from some one heat of each day's run, showed that 44 per cent of the test bars submitted during that month had an ultimate strength over 52,000 lb. and an elongation of 14.67 per cent, indicating the progress made since research work was undertaken.

The records of tests also show that, contrary to generally accepted theory, the elongation increases with the ultimate strength. The purpose of the Association, however, is not to increase ultimate strength and elongation, but to increase the uniformity of a product upon which the engineer can rely, and this is being accomplished through exhaustive research and advice to members through the consulting engineer of the Association.

A description is also given of the process of manufacturing malleable iron, of the air furnace, and of the annealing ovens and the annealing process. In the complete paper there will be found a discussion of the structures of iron containing both free and combined carbon, and the metallurgy of cast iron, numerous micrographs of typical structures being given in connection therewith.

The effects of the time element in cooling through the critical temperature, and of successive anneals, are clearly described in the abstract and in the complete paper will be found a discussion of the value of varying percentages of carbon, sulphur, silicon, phosphorus and manganese and of subsequent heating to high temperatures. Picture-frame fractures are also discussed, and the author closes by exploding three popular theories with regard to malleable iron.

PRIOR to the time four years ago that research work was undertaken in the interests of the American Malleable Castings Association, the malleable-iron industry was in a more or less chaotic condition. There had been at least three years of serious business depression and ruinous competition as a consequence had been running its insensate course, but back of and beyond all this was the damning accusation of the engineer, that the material, except in the case of a limited number of concerns, was not only lacking in dependability, but of low strength when dependable. In railway-car fabrication particularly, the number of malleable-iron castings used had dwindled from a very large quantity per car to an almost insignificant number consisting mainly of unimportant details. Malleable cast iron was rapidly being replaced by the steel casting and in other directions as well the latter was encroaching on the legitimate field of the former and incidentally placing it in an exaggeratedly false position, for the reason that when substitutions were made the patterns were redesigned and made much heavier to accommodate the less fluid casting properties of that metal. When a steel casting failed, the attitude taken by the engineer was that the maker did not understand his business, that he was incompetent. On the other hand, if the broken casting proved to be made of malleable iron, the assumption in that case was not that the maker was incompetent, but that the material, *per se*, was unsuitable for the part. Under those rather distressing circumstances it was not strange that the malleable-iron founder stopped, looked and listened.

Formation of the American Malleable Castings Association

Among the various manufacturers of malleable-iron castings, at the time referred to were some twenty-five who were progressive enough to understand the benefits that accompany coöperation, and that one might better have an intimate friend with whom to compete than an enemy. These had formed an association that had been in existence some ten years and had as its objectives the exchange of ideas in the direction of business economy, improved works practice, the study of proposed foundry and factory enactments, the securing of more favorable insurance rates, the study of problems relating to cost, labor, housing and sanitation, and finally the forming of friendships that are the natural outcome of frequent and close personal contact. It is to these men that credit should be given for the renaissance of the industry. They decided to enlarge their field of action and, irrespective of cost, determined to go the full road along the lines of metallurgical research. They determined as well that every statement made as to progress would be conservative and accompanied by data that would be incontrovertible, which course they have followed to the letter.

When the research work was started, it was found that by far the majority of the members had no system of testing the quality of their product in order to ascertain its ductility, aside from the twisting and bending of a casting, or the bending over of test lugs attached to castings. Consequently there was no way in which the quality of product of one member could be compared with that of another. Mr. Benjamin Walker, who at the time was vice-president and general manager of the Erie Malleable Iron Company, of Erie, Pa., a number of years previous to this had devised for the purpose of testing the quality and uniformity of his product, what he called a test wedge. The wedge was 6 in. long by 1 in. wide, tapering from ½ in. at its base to $\frac{1}{16}$ in. at its other end. His practice was to distribute a series of these wedges throughout the annealing oven, and at the conclusion of the anneal subject them to test—accomplished by holding the butt end of a wedge in a narrow-jawed tongs, placing it upright on an anvil, and striking its top end with a 6- or 8-lb. sledge. In this manner the thin end of the wedge would gradually curl up under these repeated blows, and it is apparent that the more blows the wedge would stand before fracture, the shorter would be the butt left in the jaws. The shortness of this butt he considered was a measure of the metal's ductility.

It was decided that an attempt would be made to standardize this test for adoption by the Association. With this end in view a machine was designed such that a weight of 21 lb. when raised to a height of 3.33 ft. above the top of the wedge (placed in position for test on the anvil of the machine) would be automatically tripped to deliver a fairly constant blow on the thin end of the wedge. The blows were counted, and for convenience the number delivered before rupture took place was recorded as the *blow efficiency* (assumed to be a measure of toughness), while the length of the butt (assumed to be a measure of ductility) was measured and expressed in terms of *butt efficiency*. These were arbitrary terms, understood by the members, and intended for their use only. Twenty blows has arbitrarily been chosen to correspond to a blow efficiency of 100 per cent, but at the present time we have numerous members whose wedges invariably test better than 30 blows. When a wedge fails to break at 30 blows without fracture, it is thrown aside, as it is obviously a waste of time to investigate it further.

[1] Consulting Engineer, Albany, N. Y.

Presented at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form, and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

METHOD OF SUBMITTING TEST BARS AND REPORTING TESTS

It was decided that tensile-test bars should be cast by all of the members, and that they be required to send to the consulting engineer one tensile-test bar and one test wedge from some one heat of each day's run. This made possible the ascertainment not only of the quality of each member's product, but furnished data through which a comparison could be made of the quality of the product of the membership as a whole. Equally important, it also served as a direct and positive measure of the progress that ensued from month to month. The dimensions of the tensile-test bar is exactly similar to that contained in the American Society for Testing Materials' specification for malleable cast iron. It is a round bar 12 in. long. The ends that go in the grips are each 3 in. long by ¾ in. in diameter, and gradually taper in a distance of 1 in. to the reduced section, which is ⅝ in. in diameter and 4 in. long. At the end of each month a report is made of the results of the tests. This report is printed and distributed in the form of a bulletin. For convenience, and in order that the situation can be easily analyzed, the results are classified as shown in Table 1.

The members are classified into those who do railway work and those who do not. To the former is assigned a letter, and to the latter a number. Through this procedure each member can identify his record but not that of any other member, as all of the identification marks are known only to the consulting engineer.

In this manner it is possible to learn just how each member is progressing, and if it is considered by the Research Committee that his progress has not been as rapid as it should have been, the consulting engineer is requested to pay him a visit with the object of aiding him more quickly to better his condition.

AVERAGE PHYSICAL PROPERTIES PRIOR TO RESEARCH

It is pertinent at this point to present in as fair and impartial a manner as possible a comparison of the physical properties of malleable iron manufactured within the past few years with that made in the period prior to 1913. Before entering into this matter the writer wishes to go on record as stating that any data in connection with the ultimate strength of malleable iron are valueless as far as serving to show its real worth, unless accompanied by information regarding the ductility of the metal as measured by the elongation. If one knows how, there is no difficulty whatsoever in making a metal of 85,000 lb. ultimate strength, provided ductility be sacrificed down to what would be represented by a 5 per cent elongation.

For many years the writer has had an unusual opportunity to learn either at first hand or on good authority what character of product most of the concerns made, and aside from one concern that had always enjoyed an enviable reputation for the uniformity and excellence of its product and another very large company whose plants were very painstaking in their methods of manufacture, the ordinary run of malleable iron was undoubtedly inferior. The tests made in this laboratory during the period mentioned do not number over three hundred. They do, however, represent the product of many different concerns. As some of the bars were of square section, some rectangular, and others round, it is plain that no uniformity existed in their dimensions. The latter vary anywhere from ½ to 1 in. in diameter, while the former for the most part are 1 in. square and 1 in. by ½ in. The great majority of these tests show that the ultimate strength was under 39,000 lb. per sq. in., while the elongations were for the most part under 3.5 per cent. There are instances of fairly high strength, slightly over 48,000 lb., while the highest elongations ran 7 per cent in 4 in.

It happens that the writer has a record of tests made in 1911 on bars made by seven concerns that were deemed at the time to be unquestionably among the very best producers of malleable-iron castings. These founders were each asked to make 20 of the very best bars they could produce for test, 10 to be 1 in. in diameter, and 10 to be ½ in. in diameter. In these tests the average ultimate strength of the 70 bars of 1 in. diameter is 39,882 lb., and the average elongation exactly 5 per cent. The lowest ultimate is 31,990 lb. and the highest 45,560 lb., the lowest elongation 1.7 and the highest 9.8 per cent. In the ½-in. bars the average ultimate is 41,693 lb. and the average elongation is 5.5 per cent. The lowest ultimate is 33,600 lb. and the highest 47,430 lb., lowest elongation 1.2 and highest 6.3 per cent. Inasmuch as each of these seven concerns were informed that what was wanted was 20 test bars that would represent the very best product they could make, and inasmuch as these manufacturers were considered among the best of the producers, it would appear that the writer is warranted in assuming that the foregoing tests would represent a high rather than a low average.

FALLACIOUS THEORIES OF MALLEABLE IRON

In Hatfield's Cast Iron in the Light of Recent Research, 1912, page 213, is a table containing the results of 14 tensile tests of bars 1 in. by ⅜ in. in section. The bars run very uniformly and the material, while of low strength, is ductile. The latter should certainly be expected in bars that are but ⅜ in. thick. The lowest ultimate strength is 38,820 lb. and the highest 45,700 lb., the lowest elongation 10 per cent and the highest 15.3 per cent. Under this table appears the following: "If attempts are made to increase the maximum stress obtained from such iron, the elongation would appear to have to be sacrificed, and to a considerable degree. In illustration of this the following records are given."

Maximum stress, tons per sq in.	Elongation, per cent in 2 in.	Reduction of area, per cent
18.9	12	9
21.1	13	8
24.0	9	8
26.5	7	5
27.8	5.5	3.5
29.0	5.0	4.2
34.3	3.0	2.5

Under this table the following words appear: "The cause of the increase in tonnage is the retention of increasing proportions of combined carbon. This combined carbon stiffens the material and incidentally reduces its ductility." The writer believes that he was the first to prove and furnish indisputable evidence as to the falsity of the statement that the ductility of malleable iron decreased as its ultimate strength increased. While Hatfield is correct in assuming that the ultimate strength is increased and the ductility decreased with an increase in combined carbon, the statements indicate clearly that he was, at the time at least, not familiar with the manner in which malleable iron can be obtained having the characteristics of high strength accompanied by high ductility. It can be stated, that in normal malleable iron as made today the higher the strength the higher will be the ductility, and in this particular this metal is unique.

In the Mechanical Engineers' Handbook, edited by Prof. Lionel S. Marks and published as late as 1916, appears the following by Dr. R. Moldenke: "These castings *should not be machined*, as the interior is not as strong as the metal at and near the surface. Tensile strength, 35,000 to 48,000 lb. per sq. in. European malleable cast iron, made by a somewhat different process, is not as sensitive to machining; the castings, which are thin only, are practically decarbonized in the annealing process; whereas in the American black-heart malleable iron only the skin is decarbonized, the metal adjacent for about ¼ in. partially so, and the central portions contain the full carbon percentage of the original hard white casting."

IMPROVED PHYSICAL PROPERTIES DUE TO RESEARCH

Improvements have been made since the research work was started and Table 1 covers the physical tests for ultimate strength and elongation on bars received during the month of March 1919.

TABLE 1 ANALYTICAL EXAMINATION OF PHYSICAL TESTS FOR ULTIMATE STRENGTH AND ELONGATION ON TEST BARS SUBMITTED DURING MARCH, 1919

Limits of ultimate strength	Per cent of bars	Per cent elongation
Under 40,000 lb.	0.40	4.50
Between 40,000 and 42,000 lb.	0.88	6.86
Between 42,000 and 44,000 lb.	2.79	7.67
Between 44,000 and 46,000 lb.	6.47	8.13
Between 46,000 and 48,000 lb.	10.29	9.50
Between 48,000 and 50,000 lb.	17.16	10.09
Between 50,000 and 52,000 lb.	17.95	11.55
Over 52,000 lb.	44.06	14.67

It would be almost impossible to consider the figures in this record and fail to note that as the tensile strength increases, so does the elongation. These monthly records have been kept for four years and there is no exception to this rule. It will also be noted that only 0.40 per cent of the total bars received tested under 40,000 lb. per sq. in. As a matter of fact, only 10.54 per cent were under 46,000 lb., while 44.06 per cent stood over 52,000 lb. with an average elongation of 14.67 per cent. The best individual record showed an average of 59,681 lb. ultimate and 21.47 per cent elongation. The worst was 39,942 lb. ultimate and 4.20 per cent elongation. The latter record belongs to a member who but very recently joined the Association, and bears out quite well the thought that the writer has been endeavoring to convey.

The members who submitted bars classified under Railway Work were twenty-two in number. The average ultimate strength and elongation of test bars submitted by the eleven members having the highest averages are found to be 53,559 lb. and 15.56 per cent, respectively. Carrying through the same operation with the twenty-six members who are not thus classified, it is found that the average ultimate strength and elongation of these thirteen are respectively 52,327 lb. and 12.42 per cent. Taking the average of these twenty-four members, we find that the ultimate strength is 52,943 lb. and the elongation is 13.99 or practically 14 per cent. Lest our intention be misunderstood, it should be explained that our effort is not directed toward securing an increased ultimate strength and elongation so much as uniformity of product. The aim is to secure a product that the engineer will readily acknowledge possesses excellent physical properties, which vary but little from heat to heat. It may be of interest to state that from January 1, 1917, to March 31, 1919, the average ultimate strength of the test bars of the Association as a whole has been over 51,000 lb. ultimate and the elongation 12.50 per cent.

In considering the last statement the following facts should be taken into account. War conditions during 1917 and 1918 made it quite impossible to secure suitable pig iron and fuel, and it was solely and only through an intimate knowledge of the metallurgy of the process derived from the research work that made such a showing possible. It is therefore not unfair to assume that a still better showing could have been made had the times been normal.

At the beginning of our investigations an elongation of 10 per cent was considered to be an indication of a superior product. As our knowledge of the metallurgy of the process increased, accompanied by better air-furnace practice and annealing-oven conditions, the elongation particularly began to climb. An elongation of 20 per cent is not now looked upon as unusual; elongations of 25 per cent occur with considerable frequency, while we have had numerous bars that have run as high as 30 per cent and several of 31 per cent, which for an untreated cast-iron product we believe to be quite extraordinary.

Process of Making Malleable Castings

The process for making black-heart malleable castings involves two steps. The first step consists in making a casting in which the totality of the carbon will exist as carbide of iron, when the iron will have a structure shown in Fig. 1. (Air-furnace white iron has an average carbon content of but 2.40 per cent as against an average of 3.50 per cent in white pig iron.) The casting produced is white in fracture, hard and as brittle as glass. The second step consists in subjecting this white-iron casting to a heat treatment such as will serve to break up this hard carbide into its two original components, graphite and iron, both of which are very soft. Hence from a white-iron casting we can obtain through heat treatment one that possesses the properties of strength, toughness and ductility. Fig. 2 shows the structure of a normal well-annealed piece of malleable iron. The white ground mass is the carbonless iron (ferrite), while the dark continent is the carbon that precipitated out during the anneal. If Fig. 2 be compared with Fig. 1, an idea will be gained of the profound change effected in the structure during the annealing process.

The air furnace, in which the malleable iron is melted, consists essentially of a fire pot, hearth and stack. Some furnaces have a solid roof, the charge being "peeled in" through the charging door, but in the larger number of cases the roof is made up of bungs that can be removed during repairs and a sufficient number of them lifted off when necessary for the purpose of admitting the charge. While a few of the furnaces operate with natural draft, most of them use a forced draft of from 3 to 4 oz. pressure. Although oil is advantageously used for fuel in a few instances where its cost is not prohibitive, bituminous coal having a volatile combustible of from 25 to 35 per cent is the heating agent used by the majority. In order to burn the volatile products of the

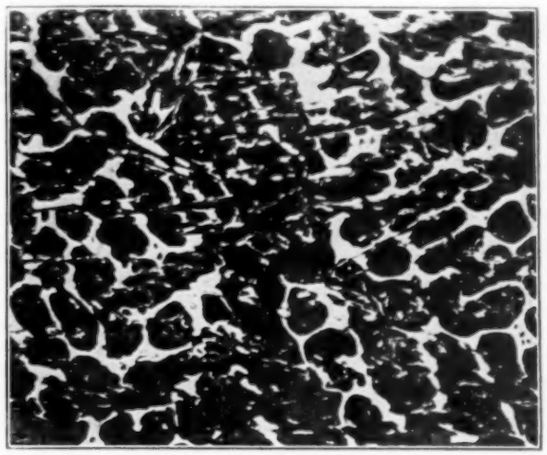


Fig. 1 Micrograph of Hard, White Cast Iron

coal, as well as the CO generated from it, when, as should be the case, a deep bed of coal is used, secondary air is admitted through a series of tuyeres or a continuous tuyere located far enough in front of the grate bridge wall and so inclined that the air will enter and be deflected about 15 in. from the base of the bridge. In this manner a maximum temperature of about 2800

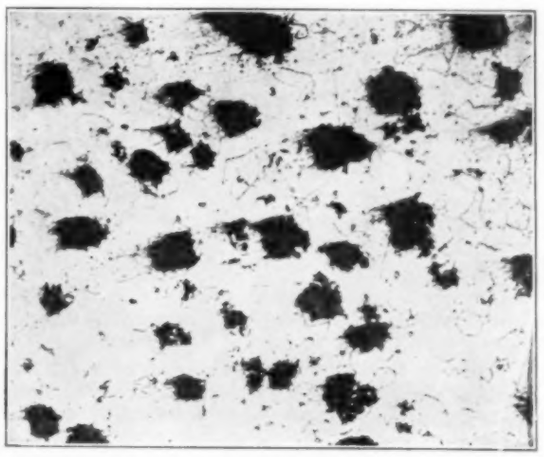


Fig. 2 Micrograph of Normal, Well-Annealed Malleable Iron

to 2950 deg. fahr. can be eventually obtained. Considerable time and thought have been expended in an endeavor to see if it would not be possible to regulate the amount of secondary air to just insure perfect combustion by the use of a CO_2 recorder, but it was found that the recorder would not act with sufficient promptness. The furnaces vary in capacity from about 7 tons to 35 tons. The best are very inefficient and in practice the fuel ratio is about three of iron to one of coal. The average practice does not exceed 2.5 to 1. In numerous cases waste-heat boilers are used and while this conserves heat, it obviously does not add to the furnace efficiency. The average furnace has a capacity of about 15 tons.

ANNEALING OF HARD IRON

When a piece of air-furnace hard iron is gradually heated, many of its properties are changed. It will cease to be magnetic and the size of the crystals will be much finer than was the case under this particular temperature. It can be carburized beyond its original carbon content if packed in a carbonaceous material and held at this temperature for a sufficient length of time, while if packed in material that yields oxygen it can be decarbonized almost completely if the piece is thin. Also the carbide of iron can be broken up into its two soft constituents at this "critical temperature," or critical range, which for air-furnace hard-iron castings is in the vicinity of 1440 deg. fahr. It is the lowest temperature at which hard-iron castings may be successfully annealed. This statement must be modified by the further statement that in an oven under perfect control this temperature is the one that would be selected. In practice it would not be safe to adhere too closely to it, for the reason that should the castings while being held "at temperature" fall under the critical range, it would undo in large measure what had been accomplished above it. In the annealing of the castings one of the things to be avoided is oscillating temperatures, or temperatures alternating above and below the critical range. For this reason it is necessary to select a temperature some 100 to 150 deg. fahr. above the critical, say, 1550 deg. fahr., in which event, even if due to carelessness the temperature does drop a little, it will not be liable to fall to a dangerous point. There is another reason why this latitude is deemed essential and this has to do with the fact that in large ovens it requires considerable ingenuity to arrange flue openings, drafts, etc., in such a manner that the temperatures in all parts of the oven will be uniform, for which reason it is necessary to make sure that the temperature at the coldest corner is somewhat above the critical range, which will serve to safeguard oscillations in these locations.

PREPARATION OF CASTINGS FOR ANNEALING

In order to anneal the hard-iron castings that have previously been barreled or sand-blasted, chipped, gates ground off and inspected, they are packed in cast-iron pots where they are surrounded by an oxidizing packing. The packing has a dual function: to furnish oxygen through whose agency the castings will be decarbonized to the extent that is possible, and to avoid kiln warp—that is, prevent the castings from distorting. The usual packing consists of a predominating proportion of inert material, such as ground air- or blast-furnace slag, pulverized firebrick, etc., to which has been added iron oxide in some form, such as rolling-mill scale, hammer scale, etc. The pots, or stands are sectional and each comprises a casting which forms its bottom, upon which four or five sections are superimposed. Each section consists of a rectangular or circular "ring" about 1¼ in. thick and varying in size at different plants, depending upon the dimensions of the castings to be annealed, but averaging, if rectangular, about 14 in. by 24 in. by 14 in. high. In building up a stand a ring is placed on the stand bottom and then carefully filled with castings that are surrounded with packing. When the ring is completely filled it is hammered on the sides with a light sledge in order that the packing will run down and fill in all voids. The second ring is then placed upon the first one, and this is filled in the same manner, which procedure is followed until the stand of four rings is completed. The top ring is filled with castings only to about two-thirds of its height, for if they were brought to the top they would be exposed to the oven gases. Instead, the top third of the ring is filled with packing and this in turn is covered with an iron plate. The top, and all joints in the stand, are then mudded or luted in order to prevent the entrance of the oven gases, after which the stand is lifted up by the charging truck and placed in position in the oven.

The annealing ovens are usually of rectangular shape, and vary in capacity from 15 tons for a very small oven to 50 for the largest ones. Their average capacity is about 25 tons. The usual fuel is bituminous coal, but hard coal, powdered coal or oil are used. These ovens are being standardized and designed with a determination of securing uniformity of temperature throughout. The flues are not only being properly proportioned for the draft used, but the flue openings so dimensioned that the heat can be drawn to any part of the oven in amounts sufficient to equalize temperatures, while provision is made whereby they can be easily kept clean. In the plants of the Association practically all of the ovens are under pyrometer control, and equipped at a central station where it is possible at any moment to ascertain the temperature at the hottest and coldest part of any oven, while a master pyrometer is used as a check on those that are permanently located. Air-furnace and annealing-oven operations have also developed from extremely crude methods to intelligent control, and this in large measure accounts for the improvements in the uniformity of the product.

LENGTH OF ANNEALING TIME AND TEMPERATURE LIMITS

In annealing, the castings are brought "to temperature," that is, to 1550 deg. fahr. or as high as 1600 deg. fahr. if thought best, as rapidly as it is deemed they can absorb the heat. Too great a forcing of the heat during this period is avoided, for if it is done the rings expand much more rapidly than the material within them, which leaving a space between ring and contents will allow the packing to bleed down from the top toward the bottom of the stand, lessening the compactness in the upper rings. In average practice it takes about 48 hr. for the oven to arrive "at temperature." The temperature of anneal is then maintained for a minimum of 48 hr., the time recommended being 60 to 72 hr. Firing is then stopped and the oven sealed tight in order that the castings will not cool faster than from 8 to 10 deg. per hr. while passing through the critical range. To safeguard this very important detail, this rate of cooling is maintained until the pyrometers indicate that the oven temperature is less than 1100 deg., for on cooling, the castings are liable to be some 200 deg. higher than indicated by the pyrometer in the oven. After the temperature has been lowered to that point an opening is made in the front of the oven in order to allow it to cool more rapidly, for the reason that once the castings are at a temperature under the critical range no change can take place in their structural composition, so the only remaining precaution is to see that the castings do not cool so fast that internal strains can develop in them. From the foregoing, it can be readily seen that the average length of anneal occupies about seven days.

From theoretical as well as practical considerations the writer does not believe that there is a possibility of safely lessening the time for this operation by much more than one day without taking chances. He has designed an oven in which the temperature of 1600 deg. can be easily attained in 25 hr. and he is aware that when the composition of the hard-iron castings is such that the hard carbide is in its most unstable condition that even less than 48 hr. will suffice for the precipitation of the carbon, so that these two periods can be reduced somewhat, but danger is ever present if liberties are taken with the cooling through the critical range. In order then to safeguard the consumer as well as his own reputation, the manufacturer should make no serious attempt to shorten the anneal unduly. The annealing capacity should be such as to make the attempt unnecessary. If it is made, however, then the pyrometer element should be inserted directly into the center of the pot, placed for that purpose in contact with the side wall of the oven, in order better to determine when the castings have actually arrived "at temperature" and the moment when he can commence to record the time the temperature can be started on its downward course, which procedure will enable him to operate more closely and accurately.

From what has preceded it should be evident that the second step in the manufacture of these castings should not be known as an annealing process, but more appropriately as a conversion process. The dominant function of an anneal is to obliterate coarse crystallization or an unsuitable one, and replace it by the most suitable that it is possible to produce in the object treated, and incidentally remove internal stresses. Annealing does not imply structural changes in the piece when cold, aside from grain size and grain refining. In the annealing of malleable-iron castings the dominant object is to convert white, hard iron, in which

all of the carbon is combined, into a soft, tough, ductile iron in which no part of the carbon is in that state. In order to achieve this it is necessary to maintain for a sufficient length of time a temperature just in excess of the critical range, which, as has been pointed out, coincides closely with that at which grain refining occurs, so it happens that during the conversion both objects can be practically attained.

APPEARANCE OF FRACTURE OF TEST PIECES

It requires an extended experience before one can tell from the fracture of the iron what may have caused its abnormal condition, which is one direction in which great progress has been made. When a normal, well-annealed piece of malleable iron is subjected to a steady, direct pull in a testing machine, a point

FIG. 3 FRACTURES SHOWING WIDTH OF DECARBONIZED RIM

is reached at which the crystalline grains of which it consists are elongated permanently, the stretch continuing until fracture takes place. If the fracture is examined it will be seen that the grains have elongated into finely pointed spines which gives what is called a "tooth" to the fracture. When light falls obliquely on such a fracture, there is produced a play of colors that yields a sheen caused by a reflection from the points and sides of the spines and the shadows that fall between them. As the grains in

FIG. 4 MICROGRAPH OF SPECIMEN WITH 0.33 PER CENT SILICON AND 0.089 PER CENT MANGANESE

the decarbonized rim are more ductile than the rest of the metal in the section, they will elongate to a greater extent, and if the fracture is held in certain directions to the light, the width of the decarbonized rim can be seen by contrast, its color appearing under those conditions a little lighter than the rest of the section. (See Fig. 3.)

This explanation is made and entered into because such a rim or border must not be confused with and mistaken for the character of fracture that has a well-defined frame, that is, a border having not only a sharp line of demarcation between it and the core of metal which it surrounds, but an appearance wholly distinct from it. If the writer were asked to pass judgment as to the quality of a piece of malleable iron, based upon either the appearance of its fracture, or what would be shown by a polished and etched section under magnification, he is positive that he could render a more reliable opinion in the case of the former than would obtain in the case of the latter. The reason lies in the fact that even in a non-ductile product it is possible to have an absolutely normal structure, one which consists of a matrix of ferrite or carbonless iron; throughout which are uniformly distributed nodules of free carbon, such as shown in Fig. 1, while if the fracture is as has been described, a normal structure at least can be predicted. If the ferrite is not ductile, then the crystalline grains will not elongate, with the result that we obtain a structural appearance that would be interpreted by those not familiar with the facts as belonging to a piece that had been insufficiently annealed. It has already been stated that when the silicon is too low a steely fracture will result, and also that the metal is liable to be unsound. In making this statement the writer is assuming that the silicon is low, not because too little was used in the charge, but due to excessive elimination in the air furnace.

In such cases the low silicon will be accompanied by low carbon and manganese. In Fig. 4 can be seen the structure of a piece that had a silicon as low as 0.33 and a manganese of 0.089 per cent. The fracture of this piece was uniformly bright and coarsely crystalline. It had no frame. The structure consists of a matrix of pearlite and throughout it are distributed particles of undecomposed hard carbide (cementite) and small well-rounded nodules of graphite, or temper carbon, as that carbon is called

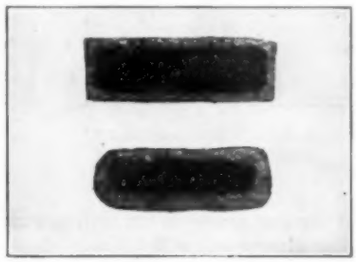


FIG. 5 PICTURE-FRAME FRACTURE IN LOW-SILICON-CARBON-MANGANESE SPECIMEN

which separates out during an anneal. The casting from which this piece was taken was in an oven in which castings of correct composition annealed perfectly, and the presence of the particles of undecomposed carbide simply means that the anneal was not carried on for a sufficiently long time for this character of product. The casting, however, would have been very inferior even if all of the carbide had been broken up.

PICTURE-FRAME FRACTURES

Very frequently certain low-silicon-carbon-manganese compositions will yield what are known as picture-frame fractures, such as are shown in Fig. 5, which are typical and have the following composition: Silicon, 0.54; phosphorus, 0.162; sulphur, 0.053; manganese, 0.108; total carbon, 2.01. This piece when polished and etched showed the following characteristics: a decarbonized surface border, an inner ring of coarsely laminated pearlite, and within this a core corresponding in structure to that of normal malleable iron. Fig. 6 shows the decarbonized border surrounding the pearlite ring, Fig. 7 the structure of the pearlite ring, and Fig. 8 the core within the pearlite ring. It is the presence of this ring of pearlite whose ductility is so much less than that of the metal in either the decarbonized border or core that produces on fracture the sharp line of demarcation between frame and core. While in this particular fracture the frame is fiery bright and finely crystalline and the core black, there are picture-frame fractures that show various color characteristics of frame and core, but it will be found that invariably the frame has its pearlitic ring of greater or less breadth. The pearlite is not always coarsely laminated, but as a rule has the appearance and con-

sists of an amount of pearlite that would correspond to a 0.35 per cent or 0.45 per cent normalized carbon steel.

If the sulphur in the hard iron is unduly high and particularly if not well balanced by the manganese, the castings will almost invariably show a picture frame on the fracture, and especially is this true if the temperature of anneal is too high for such a composition. If the manganese is too high and not well balanced by the sulphur, the same result will follow.

While time is not available to enter into a full discussion of what has been discovered in regard to picture-frame fractures, there are some points that can be recorded. There are some compositions that unquestionably have frame-producing tendencies. These compositions will not produce a frame when annealed in an atmosphere that is not oxidizing. The surface structure of the hard iron has nothing to do with the problem as the writer has had ¼ in. ground off of one side of hard-iron samples and upon annealing the frame was in evidence equally on all sides. It is believed that the following facts are pertinent to the situation: Not only do certain compositions affect the ductility of ferrite, but the same is the case with a pearlitic structure. We can have ferrite that will elongate into very long spines and ferrite that will fail to elongate at all. We can have a pearlitic grain that can be ductile and those that are not. The foregoing is stated because the writer believes that whether or not a frame will be produced in the fracture depends upon the breadth and ductility of the pearlitic ring, because a slight pearlitic ring can be present within a decarbonized border without a picture-frame fracture being produced. It is his belief that whether there will be a pearlitic ring or not depends upon the rate of surface decarbonization as compared with the rate at which a dissociation of the cementite takes place. When conditions are such that there will exist a region between the decarbonized surface border and the core that will have a carbon content of about 0.90 per cent, equilibrium seems to be established in this region, and if any carbon passes from this region to the decarbonized border it is replenished by carbon from the core.

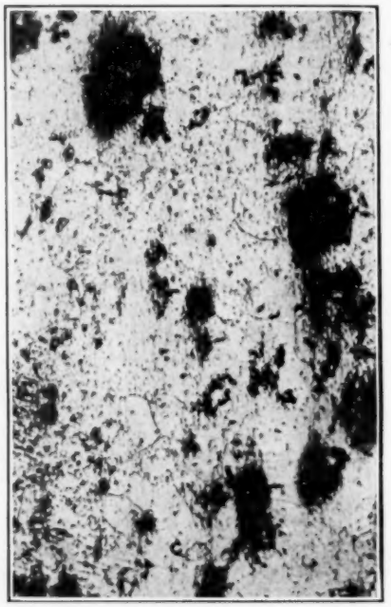


FIG. 6 MICROGRAPH OF DECARBONIZED BORDER

FIG. 7 MICROGRAPH OF PEARLITE RING

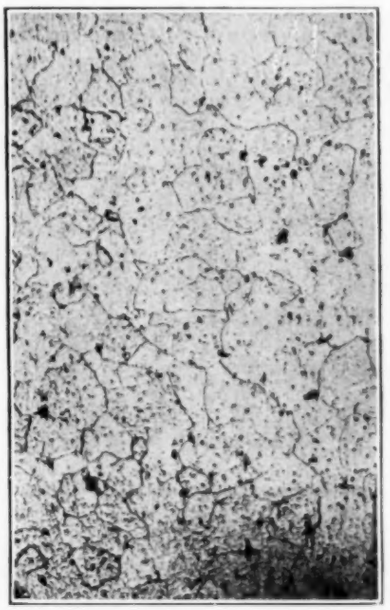


FIG. 8 MICROGRAPH OF CORE WITHIN PEARLITE RING

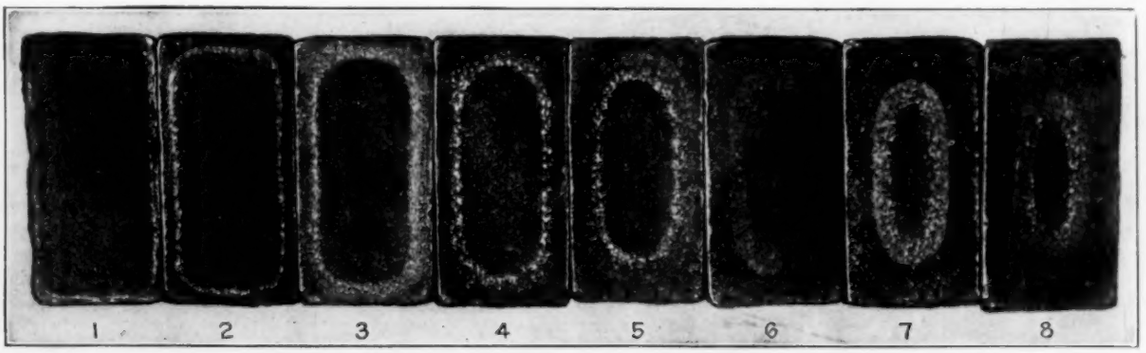


FIG. 9 THE PEARLITIC RING IN SUCCESSIVE STAGES OF ANNEALING

THE PEARLITIC RING

The writer believes that such is the case, and is of the opinion that perhaps the samples shown in Fig. 9 may have a bearing on the case. A well-annealed bar was cut into eight pieces. A section from the first piece was polished and etched, and the other pieces all packed together and given another anneal. The second specimen was then prepared like the first. The remaining six were then given a third anneal, and the third piece polished. As this procedure was continued, it follows that the eighth bar had

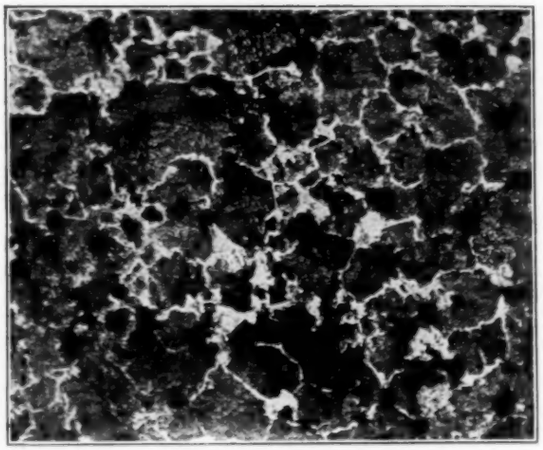


FIG. 10 MICROGRAPH OF MALLEABLE IRON OF HIGH ULTIMATE STRENGTH

eight separate and complete anneals. It will be noted that its very faint pearlitic ring which shows whitish and very faint in the once-annealed bar, is very distinct and well defined in the second and that it is wider and further in toward the center. It will be seen that with each anneal the pearlitic ring has widened and has a smaller periphery. As it was found that with each anneal the total carbon content decreased, it is plain that once the pearlitic ring has formed, it does not act as a seal for the passage of carbon from core to surface and that the width of the pearlitic ring is while permitting carbon to migrate or diffuse through it will at the same time be incapable of having its carbon precipitated. Under proper conditions the region can alter its position and increase in extent. For such a region to have a start it is essential that there be a very substantial difference in carbon content in two parts of the section.

STRUCTURE OF HIGH-STRENGTH MALLEABLE IRON

Malleable iron of very high strength accompanied by a ductility that can be considered good enough for certain purposes, has already been mentioned. While no effort has been made to exploit this product as yet, it would appear to the writer that there is a very large field in which it could be used to advantage. In Fig. 10 can be seen the structure of a sample that stood an ultimate strength of 84,000 lb. and had an elongation of 5.20 per cent. This material can be made with uniformity and it is believed from experiments that have been under way for some time that a 90,000 lb. ultimate and a 10 per cent elongation might be uniformly maintained. It will be noted that the structure consists of a ground mass of pearlite, in which are more or less uniformly distributed nodules of temper carbon. The structure readily explains why the product is of high strength.

EFFECTS OF HEATING MALLEABLE IRON

As it is frequently necessary to heat the finished product for the purpose of straightening it, for galvanizing and other purposes, it may prove instructive to see what happens when an annealed piece of malleable iron is heated up to and beyond the

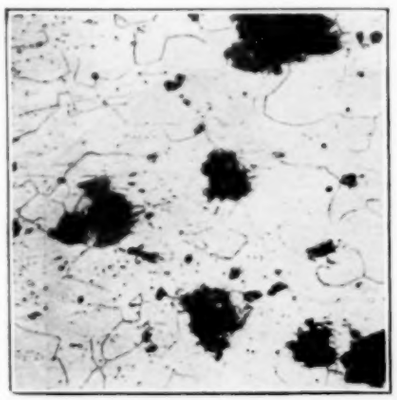


FIG. 11, Unheated

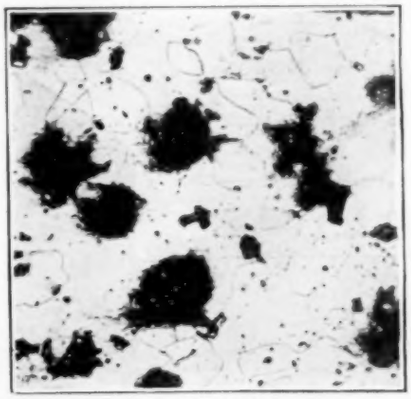


FIG. 12, 1400 deg.

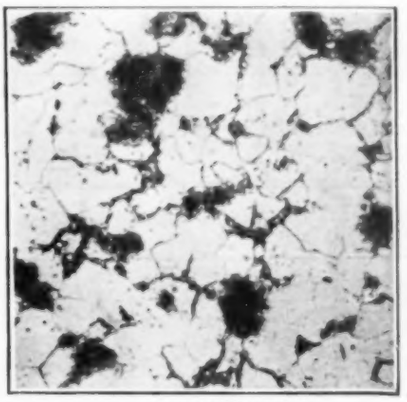


FIG. 13, 1450 deg.

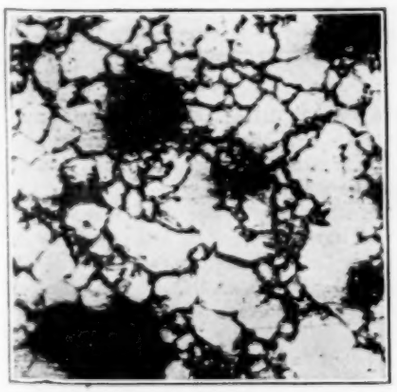


FIG. 14, 1475 deg.

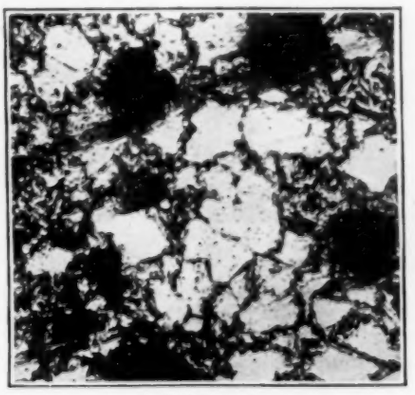


FIG. 15, 1500 deg.

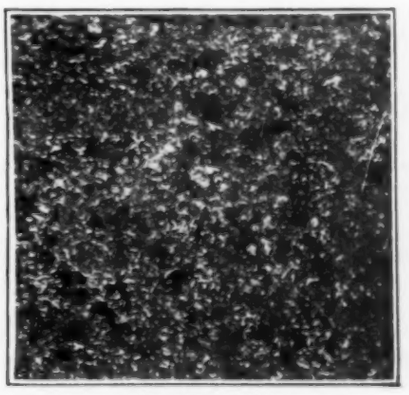


FIG. 16, 1675 deg.

FIGS. 11 TO 16 MICROGRAPHS SHOWING EFFECT ON STRUCTURE OF HEATING TO VARIOUS TEMPERATURES

built up and added to more quickly from the core than it is robbed of carbon by the decarbonized border. The matter can be summed up as follows: If conditions are such that a region containing about 0.90 per cent or less carbon is formed, this region critical range. Ten pieces were cut from a normal, well-annealed malleable-iron bar. Fig. 11 shows the structure of this bar at 200 diameters. The pieces were then placed in an annealing oven that could be controlled with great accuracy. When the pyro-

meter registered 1250 deg. fahr., one piece was withdrawn and allowed to cool in the air. When the temperature reached 1300 deg. fahr. another piece was withdrawn. The other pieces were withdrawn at temperatures of 1350, 1400, 1450, 1475, 1500, 1550, 1600 and 1675 deg., respectively. Fig. 12 shows the structure at 1400 deg., Fig. 13 at 1450 deg., Fig. 14 at 1475 deg., Fig. 15 at 1500 and Fig. 16 at 1675 deg. All of these micrographs were taken at a magnification of 200 diameters. It is apparent that no change has taken place in the structure up to 1400 deg., but that somewhere between 1400 and 1450 deg. the structure starts to alter in appearance. An examination of Figs. 13 to 16 shows that increased amounts of pearlite result as the temperature is increased, and that in Fig. 16 nearly all of the temper carbon has been dissolved. It follows that for straightening, brazing and other operations that necessitate the heating of a malleable-iron casting, the temperature used should be well under 1400 deg. fahr.

Common Fallacies

The fallacies that have been handed down and accepted by many of the engineers and consumers as true are numerous, but the following only will be touched upon as they are the most important:

a The strength of malleable iron lies in the skin. When it has been removed the remainder of the metal is found to be very inferior and not dependable.

b During the anneal, the elimination of the carbon is confined to the surface, and the amount removed from the rest of the section is inconsequential.

c When the section of a casting exceeds $\frac{5}{8}$ in. in thickness, it cannot be annealed throughout.

Concerning item *a*, the data in Table 2 will prove of value.

TABLE 2 TESTS OF MALLEABLE-IRON BARS WITH DECARBONIZED SKIN REMOVED

Mark	Ultimate strength, lb. per sq. in.	Per cent elongation in 2 in.
12-2-1	52,084	17.50
12-3-1	47,182	10.00
12-3-2	51,107	17.50
12-4-1	56,732	14.00
12-5-1	46,482	7.00
12-5-2	52,246	23.00
12-6-1	47,889	19.00
12-7-1	48,080	18.00
12-7-2	49,640	18.00

Nine regular test bars were machined until the decarbonized surface was removed. These bars were all from different heats and marked as indicated in the table.

As the writer did not have duplicates of these bars, he was unable to make a comparison between the machined and the bars as cast and lacked time to run through a set for illustration, but the experiment should be unnecessary in any event in view of the above. It is obvious and must be acknowledged that the metal in the decarbonized skin is more ductile than the core, so when a bar fails it must be conceded that it is the core that has parted first, for the reason that the metal in the skin has not at the instant of fracture reached its maximum elongation. Aside from the foregoing we have the practical evidence that presents itself in the case of the automobile industry in which thousands of tons of machined malleable-iron castings are used annually on parts that receive in service great abuse, such as wheel spindles, etc. On the other hand, the writer not only admits that when the skin is machined off some malleable-iron castings the remaining part is worthless, but admits as well that the castings would be such with the skin on. This, unfortunately, will continue to be the case until the purchasing agents cease to shop around and make contracts with price as the basis rather than quality.

Taking up item *b*, the writer can, without encumbering this paper with the large amount of data he has on the subject, prove the falsity of this contention. In the figures quoted in Table 3 of the complete paper for bars of over 52,000 lb. ultimate strength and over 20 per cent elongation, there will be noted two bars, one of which has a carbon content of 0.72 per cent and the other of 0.82 per cent. Aside from this there are fourteen with a carbon content of 1.50 and under. It has already been pointed out that the carbon in the hard iron must be kept up to a certain figure, failing which the castings will not only misrun, but contraction cracks will spoil them. If we assume, in the case of the first two bars referred to, that the carbon was reduced by one-half, then in the bar that had but 0.72 per cent carbon, the carbon in the hard iron from which it was cast must have been 1.44 per cent, and we all know that it would be almost impossible to run such work, say nothing about subsequently annealing it. In a $\frac{5}{8}$-in.-diameter annealed bar such a low carbon content is unusual but it proves the point that is being made nevertheless. The writer has polished the section of two $\frac{5}{8}$-in.-bars and has photographed them at about seven diameters. One of these is shown in Fig. 17 and will furnish a fairly good idea as to how the carbon is distributed throughout the section, and indicate that the carbon does not vary by uniform gradation from surface to center, but in one region can vary slightly from what it may be in another. This does not signify that in the regions of highest carbon content the carbon has not been lowered through diffusion into its contiguous region, for many investigations have shown that this is just what does happen.

Item *c* can be disproved in a few words. We know that in order to break up the hard carbide in white iron it is simply necessary that the casting be not only heated until the iron is in an austenitic condition, but maintained at that temperature for a certain interval of time. To state that thick castings of white iron cannot be annealed is to state that they cannot be brought to a uniform temperature throughout and maintained at that temperature. Such a claim would be an absurdity.

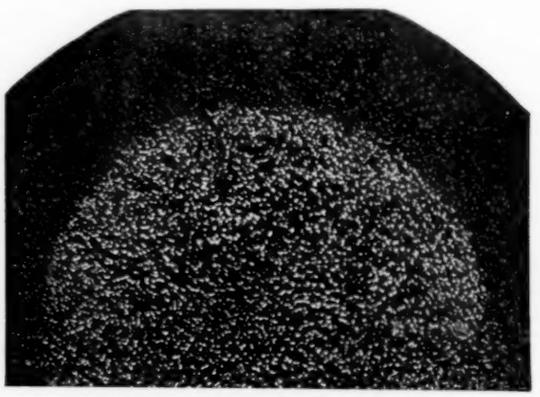


FIG. 17 BAR MAGNIFIED SEVEN DIAMETERS TO SHOW CARBON DISTRIBUTION

For the benefit of those who labor under the impression that malleable iron is a product unsuited for any but small castings, the writer would say that he has a photograph of a casting 5 ft. long, 23 in. high with some of its sections 3 in. thick. The metal when well made, can also withstand great abuse. Irrespective of how good the metal may be, as shown by physical tests on bars and wedges, patterns are often furnished so outrageously out of proportion that the good qualities of the metal can easily be destroyed and too frequently the metal is blamed when the design is at fault. These troubles are overcome as far as possible by a thorough study of the best method of gating the casting, in order that no evidence of shrink will be present in any part. Research has made considerable advance in this direction and well-placed, well-proportioned shrink heads are now generally used. Not infrequently, in the case of such castings as the ones referred to, the sprue, runners and heads weigh about as much as the casting.

Committee on Aims and Organization

Tentative Report of the A. S. M. E. Committee, Dealing with Society and Professional Activities and Relations of the Engineer to the Community

FOLLOWING the business meeting at the Spring Meeting of The American Society of Mechanical Engineers on Monday, June 16, the report of the Aims and Organization Committee was presented by its chairman, Louis C. Marburg. This report evoked so much interest that sessions for its discussion were required on three different days. The report is published herewith both in its original form and with the resolutions as amended at the meeting. The report was discussed section by section, and the synopsis of discussion herewith reported is grouped under the several headings to which it belongs.

In presenting the report, Mr. Marburg stated that the committee considered it as tentative and in making its recommendations felt very strongly that it should avoid giving too many details but should state, instead, its views along lines of broad principles. The chairman of the meeting, President Cooley, then called upon Prof. Dexter S. Kimball who said the committee desired it to be understood that the report was not the work of a small body of men anxious to tear down something simply because it existed as a committee; nor did they want to introduce radical ideas into the report simply because of their own points of view.

As nearly as he could place his finger on the origin of the documents, it started with the Committee on Meetings and Program of which he had been a member for some years. In the work of that committee it was necessary to arrange for papers and it had been difficult to get unanimity of opinion as to what the aims of the Society really were and what kind of papers should be presented.

He called attention, however, to the fact that the A. S. M. E. was not alone in the matter and that every society of note in the country is now wrestling with the same problem, every university is wrestling with it and every technical school. The work of the Aims and Organization Committee had been sub-divided in the way noted in the report, with the committee split into three groups and a chairman appointed for each; the work had been conducted by sending out questionnaires from which a great mass of information, criticisms and suggestions had been received. That matter was boiled down and so arranged that the committee as a whole could pass upon it, and constituted, in effect, a composite opinion of a large number of members. A great deal of the work was done by correspondence and recently the three subcommittees met in conjunction and each framed recommendations which were then submitted to the committee as a whole and endorsed by the committee.

RECOMMENDATIONS OF THE COMMITTEE ON AIMS AND ORGANIZATION

Text of the Report as Modified by Vote of the Meeting, Together with the Committee's Wording Where Changes Were Made

The Professional Activities of the Society

OUR discussion of the professional activities of the Society undertaken for the benefit of mechanical engineers led to the opinion that this work can well be strengthened in practically all its branches. The specific recommendations for the development of professional activities follow:

Adoption of Standards

2. RESOLVED: that it is the sense of this meeting that Section C-49 of the Constitution of The American Society of Mechanical Engineers be amended so that the Society may approve and adopt such professional reports and standards as shall from time to time be presented to it. [The foregoing resolution was adopted in place of the resolution printed by the Committee, which was the same except that it did not include the words "That it is the sense of the meeting."]

3. The purpose of this change is to permit the Society to adopt an active progressive policy in place of the present passive policy.

Professional Features of General Meetings

4. RESOLVED: that continuous tenure of membership on the Subcommittees of the Meetings and Program Committee be discontinued, that the classification of engineering activities be retained and extended, and that the means and methods of collecting information under this classification be enlarged and improved.

5. The purpose of these changes is to get better papers of broader scope.

6. RESOLVED: that all Sub-Committees of the Committee on Meetings and Program be appointed for limited terms, all memberships to expire automatically at the end of said terms, but a sufficient number of experienced members should be selected, when reconstituting any such committee, to secure continuity of policy.

Research and Standardization

7. RESOLVED: that the Society, in addition to the work it is now doing in aiding, recording and publishing matters pertaining to research take a more active interest in this field by the following methods:

a. By increasing the appropriations made from its own funds to further research and by obtaining from other sources funds to conduct research.

b. By determining and formulating problems requiring investigation, and by securing men and facilities to solve these problems.

8. RECOMMENDED: that the Society establish the policy of formulating and adopting engineering standards, but that, in general, these be limited to elements, and that the standardization of combinations be left to organizations devoted to special industries.

9. RECOMMENDED further: that all such standards be considered as progressive standards and not as ultimate ones.

Industrial Engineering

10. RESOLVED: that Industrial Engineering is a major subject for consideration by the Society, and should be placed on a par with all major technical subjects.

Education and Special Training

11. RESOLVED: that the Committee heartily approves the work now being done in connection with the Student Branches and technical schools of higher grade in general, and recommends that this work be strengthened as much as possible.

12. RESOLVED: that in the opinion of the Committee, the Society is not realizing its opportunities in connection with industrial education below the grade of college work, and recommends the formation of a strong committee to take up this activity vigorously.

13. The reason for this recommendation is found in the need of the engineer for trained subordinates and industrial workers.

14. *Professional Groups.* The By-Laws of the Society provide for professional sections, under a clause of the Constitution (C52). Several requests for such sections, including an Ordnance

Section, a Power-Plant Section, an Automotive Section and a Petroleum Section, have recently been received.

15. RECOMMENDED: that a standing committee on Professional sections be constituted, analogous to that on Local Sections.

Development of the Society's Publications

16. Resolved: that the Committee on Publications and Papers be encouraged to publish in MECHANICAL ENGINEERING (The Journal) matter of broader scope, including papers and articles that have not been presented at any meeting of this Society, news items of engineering interest, and the information of general interest now presented in Bulletins.

[In the resolution before amendment the resolution read: RESOLVED: that MECHANICAL ENGINEERING (The Journal) be made a weekly publication at the earliest possible date, and that the Committee on Publications and Papers be encouraged to publish matter of broader scope, etc. (as continued above).]

17. RESOLVED: that the Committee on Publications and Papers be requested to study the possibility of a substitute for the present expensive method of publishing the Transactions, reporting any plan developed at the Annual Meeting.

[In the resolution before amendment, the last clause read "presenting any plan developed to the members of the Society for letter ballot.]

18. RESOLVED: that the Society publish, as soon as practicable a Handbook of Mechanical Engineering Data.

Absence from Committee Work

19. RESOLVED: that the Council formulate and put into force such rules as will cause membership on any Council or Committee of the Society to terminate automatically on account of absence or neglect, either willful or due to force of circumstances.

Engineering Societies' Employment Office

20. RECOMMENDED: that the present Joint Employment Bureau in New York be retained and its activities be expanded and made more efficient.

21. RECOMMENDED further: that the name of employment officials be secured especially through the local sections, and that these officials be supplied with lists of men.

Code of Ethics

22. RESOLVED: that it is the sense of this meeting that a short Code of Ethics of broad scope, general character and positive rather than negative injunction, be prepared and that the same be enforced vigorously.

22*a*. RESOLVED: that a committee of five on Code of Ethics be nominated by the President and confirmed by the Council, who shall report back to the Society at the Annual Meeting.

[The foregoing resolution was adopted in place of the following resolution presented by the Committee:

22. RESOLVED: that the present code of ethics of our Society be abolished as unnecessary and unenforceable.]

Relations of the Mechanical Engineer to the Community

(NOTE—In order to avoid confusion, the term "technical societies" will be used to refer to the four Founder Societies and such others as confine their activities to specific professional or technical phases of Engineering. The term "general engineering societies" will be used to cover the federation—local, state or national—on such basis as may develop, of the various technical societies, their sections and others concerned with engineering.)

23. In the opinion of the Committee, the relations of the engineer to municipalities can best be cultivated through group activity, proper groups being the local general engineering societies which should include engineers of all classes. In state affairs, these relations may be developed through a coalition of such local groups into state associations, while matters of general and national interest may be handled by a national organization of such local, district and state societies. Such a system of societies is considered below.

24. The entity of the various local sections of the technical societies should be preserved, but they should form part of the local general engineering societies. In dealing with public affairs, their members should act as members of the general engineering society and *not* of the technical section.

25. Distinctly technical work such as the formulating and publication of safety codes, the fixing of standards, etc., should be done by those technical societies which, jointly or severally, are concerned with the particular subject; e. g., the Boiler Code by The American Society of Mechanical Engineers, wiring standards by the American Institute of Electrical Engineers, etc. But the agencies for bringing about their general adoption and legalization should be the general engineering societies local, district, state and national.

26. As embodying the above, the Committee presents the following resolutions:

27. *Whereas:* The Committee on Local Sections has been engaged in promoting coöperation between Local Sections of the American Society of Mechanical Engineers and other local engineering organizations, and

28. *Whereas:* it is desirable that this coöperation be encouraged and further vigorously developed not only among local but also among national engineering organizations, and

29. *Whereas:* engineering solidarity should be established to enable the profession to more effectively serve the community at large, therefore be it

30. RESOLVED: that the policy heretofore pursued by the Committee on Local Sections is heartily endorsed, and be it

31. RESOLVED: that the Council of the Society should actively encourage further development of coöperation both in local organizations under the leadership of local engineering societies, and in state or territorial groups, which can effectively handle state or territorial problems. This coöperation to take such form as will most readily lend itself to national coöperation, and be it

[In the resolution before amendment the words "as in Philadelphia or Cleveland" followed "local engineering societies," and the words "as in Minnesota or Ohio" the words "territorial problems."]

32. RESOLVED: that there should be created some agency of a national character through which the coöperation of local groups, state groups and national societies can be secured for purposes of national scope. This agency to be composed of representatives of the members of local groups, state groups and national societies. It should be an organization capable of speaking in the name of the profession, and be it

[The last sentence of the foregoing resolution before amendment read: "It should be an independent organization, fully empowered to act and capable of speaking in the name of the profession, and be it"]

33. RESOLVED: that The American Society of Mechanical Engineers should collect and publish in pamphlet form the various modes of coöperative organizations used in different localities, thus enabling each group of organizations contemplating coöperation, to more readily select the method best adapted to their local conditions.

34. Acting through the organizations above suggested, service to the community may best be promulgated along the following lines:

35. *Legislation.* Protection of Health, Life and Comfort—By securing the introduction of safety codes, of which the Boiler Code is an example, by securing the adoption and enforcement of measures for smoke prevention, the inspection of elevators, and the use of safety methods and appliances in the industries, etc.

36. Production, Distribution and Sale of Commodities—By the establishment of standards of size, strength and quality of manufacture of products, of standards of material, and standard methods of testing materials and performances.

37. Industries, Utilities and National Resources owned or controlled by Communities—By initiating and guiding legislation for their operation, development and conservation, and particularly by developing and securing the adoption of uniform systems of accounts and reports for public utilities, *both* privately and publicly owned.

38. Legislation for Protecting the Public in Engineering Affairs—By action to secure uniform State and Federal laws for the registration and certification of professional engineers whose work involves the public health, safety and well-being.

39. *Administration.* Placing Engineers in Public Positions requiring Engineering Training—By efforts to bring about the appointment rather than the election of engineering officials, and to secure the appointment and retention of the best grade of engineers in the public service; and also by cooperation with such civic bodies as the Civil Service Reform League.

40. Coöperation with Engineers in Public Positions—By encouraging such engineers to become members of the local general engineering societies, and by giving them the support of such societies when political or other influences seek to interfere with the proper exercise of their functions. The reports of such engineers may be made profitable and mutually helpful subjects of discussion and review by such societies.

41. Selection of Engineers to Meet Public Emergencies—The organization of the profession through general engineering societies seems to offer the best means for the prompt direction of the talent and efforts of engineers classifies as to their special abilities and experience, would be helpful in this connection.

42. *Enforcement of the Law.* By action in conjunction with other civic bodies rather than independently.

43. *Public Opinion.* By an active, but dignified program of education in the public press. This should be free from objectionable advertising and of a character which would broaden the public knowledge of, and its appreciation for, engineering achievements.

44. *Industrial Relations.* By active participation in the solution of the industrial problems now before us.

45. In his Presidential address before this Society in 1882, the second year of its existence, Dr. Thurston said:

> In singular and discreditable contrast with all the gain in recent and current practice in engineering, stands one feature of our work which has more importance to us and to the world, and which has a more direct and controlling influence upon the material prosperity and the happiness of the nation than any modern invention or than any discovery in science. I refer to the relations of the employers to the working classes, and to the mutual interests of labor and capital. It is from us, if from any body of men, that the world should expect a complete and satisfactory practical solution of the so-called Labor Problem. More is expected of us than even of our legislators. And how little has been accomplished?

46. Mr. Marburg in the progress report of this Committee in December last, said:

> Among all the educated classes, the engineers are the one group in closest touch with labor. It is the part of wisdom and our duty to Society to try to understand the strivings of the working classes for our own benefit and to interpret them to the rest of the community. If the British Labor Party has been able to frame a reconstruction program and to produce a document commanding the admiration of most thinking men, surely it behooves us, the engineers, the men of whom, on account of training and experience, industrial leadership might reasonably be expected, to discuss the mighty problems now before us.

47. The engineer was the first to attempt a definite solution of the problems involved. He has contributed most of the constructive work which has been done to date, and on him rests the principal burden of an adequate and constructive solution.

48. The political autocracies of the world have been overthrown, but industry remains to be democratized. Labor is not going to be contented with its present subservient and limited condition, and its discontent will not be ameliorated by welfare work or other manifestations of benevolent despotism. The engineer stands between opposing interests, frequently between extremists, the self satisfied obdurate employer who still regards labor as a chattel on the one hand, and on the other the radical laborite who would confiscate all forms of property. With his analytical habit of thought, his experience in estimating and directing physical and industrial forces, he must devise industrial methods which will insure greater and more efficient production and a more equitable distribution of it, and he must take the lead in their adoption.

49. As outlined above, action in public affairs should be through the general engineering societies, but discussion is distinctly within the province of our own Society. The Committee therefore presents the following resolution:

50. RESOLVED: that the Society should enlighten its membership in regard to all Federal, State and Local problems which should interest engineers, and in the solution of which their experience and training may be helpful.

Election of Officers

51. *Regular Nominating Committee for Elective Offices.* The Council referred the recommendations of the Committee on Local Sections and the Committee on Constitution and By-Laws on the manner of election of the Regular Nominating Committee by the voting membership to the Committee on Aims and Organization.

52. The plan of the Local Sections Committee was to utilize the organization of the local sections to affect this election, while that of the Committee on Constitution and By-Laws proposed dividing the country up into 15 districts of approximately equal membership and having one member on the Committee from each district.

53. The Committee on Aims and Organization carefully considered both the relative merits of the two plans and passed the following resolution:

54. RESOLVED: that it is the sense of the Committee on Aims and Organization that the regular nominating committee for the election of officers, as provided for in C48 of the Constitution, be composed of a member from each local section; provided that each voting member of the Society be assigned to some local section by the Committee on Local Sections exclusively for the purpose of electing a nominating committee member, and provided further that members of the Nominating Committee shall be elected annually for one year, and no member shall be eligible for more than two consecutive terms.

Time of Election

55. RESOLVED: that the Committee on Constitution and By-Laws be requested to prepare such changes in the procedure for the annual elections of officers as will permit the declaration of their election by a considerable time to be determined by the Council. [In the resolution before amendment the fourth line read "their election by November first."]

Information on Candidates

56. RESOLVED: that biographical sketches of all candidates for office in the American Society of Mechanical Engineers should be sent out with the ballot for election to office of the Society.

Respectfully submitted,

L. C. MARBURG, *Chairman*	MEMBERS AT LARGE
D. S. KIMBALL	
L. P. ALFORD	
F. R. LOW	
JAMES HARTNESS	
W. F. M. GOSS	
S. B. ELY	

Section

R. W. ANGUS	Ontario	SECTIONS DELEGATES
C. H. BIERBAUM	Buffalo	
L. P. BRECKENRIDGE	Connecticut	
E. S. CARMAN	Cleveland	
R. COLLAMORE	Detroit	
A. G. DUNCAN	Boston	
J. T. FAIG	Cincinnati	
H. P. FAIRFIELD	Worcester	
H. GASSMAN	Birmingham	
L. GUSTAFSON	St. Louis	
J. L. HENNING	New Orleans	
C. E. LORD	Chicago	
L. V. LUDY	Indianapolis	
T. C. MCBRIDE	Philadelphia	
G. K. PARSONS	New York	
C. H. REPATH	Los Angeles	
L. E. STROTHMAN	Milwaukee	
C. M. SPALDING	Erie	
E. F. SCOTT	Atlanta	
C. W. TUBBY	Minnesota	
A. E. WALDEN	Baltimore	
J. T. WHITTLESEY	San Francisco	
G. A. WESCHLER	Washington	

DISCUSSION OF REPORT OF THE COMMITTEE ON AIMS AND ORGANIZATION

Adoption of Standards

The first resolution considered was as follows:

> 2. Resolved: that Section C-49 of the Constitution of The American Society of Mechanical Engineers be amended so that the Society may approve and adopt such professional reports and standards as shall from time to time be presented to it.

The section of the Constitution referred to (C-49) now reads: "Reports of such committees (Professional Committees) may be accepted by the Society and printed in the Transactions, but shall not be approved or adopted as the action of the Society."

The discussion of this resolution was mainly in the direction of clarifying ideas as to present procedure in passing upon reports, and as to the necessary changes in this practice in the event of the resolution going into effect. Secretary Rice explained that reports are now considered as recommended practice, ordered printed by the Council. The committee's names are affixed to each report so that a person reading a report can form his own opinion as to its authoritative character. Under the new conditions, instead of using the Society simply to give voice to the report, it would have the official approval and stamp of the Society.

Dexter S. Kimball said that the Aims and Organization Committee considered this one of the most important resolutions presented and that it reflected the suggestions received from a large number of members of the Society. If the Society believes in the Boiler Code, for example, why not say so and stand back of it? Alex Dow favored the present practice by which a standard is regarded as a gospel which may well be followed, rather than a creed which must be subscribed to. S. N. Castle held that an adopted report should be considered as carrying the minimum requirements rather than the maximum; an engineer could make his specifications as much better than called for by a report as he saw fit.

Major Fred J. Miller pointed out that the resolution as presented was in effect a proposition to amend the Constitution and that the vote should not be to that end, for which ample provision is made in the Constitution itself, but for the purpose of expressing approval or disapproval of the practice recommended. Past-President Jesse M. Smith accordingly proposed the following modification of the resolution, in which form it was adopted:

> Resolved: that it is the sense of this meeting that Section C-49 of the Constitution of The American Society of Mechanical Engineers be amended so that the Society may approve and adopt such professional reports and standards as shall from time to time be presented to it.

Professional Features of General Meetings

Arts. 4 and 6 of the report proposing that continuous tenure of membership on the Sub-Committees of the Meetings and Program Committee be discontinued and that such sub-committees be appointed for limited terms only, formed the subjects for discussion under this heading and were approved.

Dexter S. Kimball, Chairman of the Meetings and Program Committee, explained that the sub-committees referred to were intended to supply material for certain of the sessions at the Spring and Annual Meetings; and that sometimes they were effective and sometimes not. Instead of maintaining these as standing committees with continuous tenure of office, it was proposed to appoint committees for a fixed term as required, in order to carry out definite assignments, after which the members would go out of office automatically. By this means no committee could remain for several years on the list in the Year Book without accomplishing results.

President Cooley, referring to committee activities in general, said he had sent a letter to all members of committees and to all chairmen of Local Sections, requesting information as to the work of the committees in the first instance, and as to who were available for committee appointments in the second instance. In July he would go over the replies received and investigate the work of the various committees.

Research and Standardization

Arts. 7, 8 and 9 were next taken up. These proposed that the Society secure and appropriate funds for the conduct of research; formulate problems for investigation, and secure men and facilities for their solution; and that the Society establish the policy of formulating and adopting engineering standards (which, however, should be limited to elements), such standards being considered as progressive and not as ultimate. The resolutions as presented were approved.

W. E. Symons, Chairman of the Finance Committee, issued the warning that "we can't by resolution or legislation make one dollar into two," and stated that the appropriation for the Research Committee for the present year had been $4000, of which a considerable amount as yet remained unexpended. In response to his inquiry as to the desires of the Aims and Organization Committee with respect to funds and appropriations, Mr. Alford said that the committee was dealing with principles only and that there was no time limit whatever on the resolution. There was no thought of changing this year's appropriation, but that as the Society grew and its income increased it was believed that it should be the duty of the Society to secure and appropriate larger funds for research work.

Secretary Rice said that he hoped the Society, with an annual budget of $300,000, would appropriate more than $4000 for research. It should so spend at least one-tenth of its income, which, in good Bible terms, is considered a tithe of its income, for the benefit of others. The American Society of Heating and Ventilating Engineers, with a membership of about 1100, had collected a fund of $80,000 for the advancement of their art and science and Dean Allen of the University of Minnesota was to be the director of their research work at Pittsburgh. If necessary to accomplish the purpose, there could be a readjustment of our funds, certain committees receiving smaller appropriations and the Research Committee more. Past-President Oberlin Smith testified to the pressing need for research as shown by the discrepancies in the information given in our handbooks. C. H. Bierbaum, Chairman of the Sub-Committee on Bearing Metals, also emphasized the importance of research and standardization and said that it was a happy conclusion to the resolutions that they recommended simply the standardization of elements and not the combination of elements and that the work be not considered final at any time. During the discussion Frank B. Gilbreth, who had recently studied conditions in England, urged as an important subject for study and investigation, the fatigue of working men and women.

Industrial Engineering

The next resolution, Art. 10, recommending that Industrial Engineering be made a major topic of discussion, was introduced by Walter B. Snow, and at once brought a call from Alex Dow for a definition of Industrial Engineering, and from Charles E. Lord for an explanation of the distinction between the expression "Industrial Engineering" and that used later in the report, "Industrial Relations." Several tried their hand at definitions, a definition of industrial engineering. Mr. Snow said it was "engineering which has to do with industry." Professor Kimball said it was a well-understood term, difficult to define. It related more to the construction and operation of factories as distinguished from the design of clearly defined engineering construction. Robert T. Kent offered as a definition, "The application and use of the materials and machines of engineering in the industries; this to include problems of management and labor." Mr. Gilbreth gave a definition attributed to Mr. Kent's father, the late William Kent, who used to say, "Engineering is the

science of overcoming the resistance of nature, but industrial engineering is the science of overcoming the resistance of human nature." Professor Kimball explained that, assuming industrial engineering to have to do with the construction and management of plants, there exists a field still further away from design that has to do with the human element—the field of industrial relations between employer and employee, in which engineers can play a very large part.

Without further discussion the resolution of Art. 10 was adopted.

EDUCATION AND SPECIAL TRAINING

Arts. 11 and 12, introduced by Sumner B. Ely, approved the work now being done by the Society in connection with Student Branches and technical schools of higher grade and recommended that this work be strengthened; and that a strong committee should be formed to extend this work among the industrial school below the grade of colleges. Louis C. Marburg, Chairman of the Committee on Aims and Organization, expressed the belief that the field offered great opportunities of such importance to engineers that it should have thorough consideration by the Society. The resolutions were adopted.

PROFESSIONAL SECTIONS

In view of the fact that there had been several requests for professional sections, as provided for by the Constitution, such as an ordnance section, power-plant section, etc., the resolution in Art. 15, introduced by S. N. Castle, was proposed, recommending a Standing Committee on Professional Sections. This resolution was approved after a brief discussion calculated to bring out the purport of the resolution. L. C. Marburg explained that as it was proposed to broaden the scope of the Society—with the attending danger that it might become superficial in dealing with technical subjects, it was desirable to have professional groups to which specific topics could be referred for treatment. In response to an inquiry, Mr. Marburg said that such groups would naturally form in the sections of the country where the industries which they represented were centered, but nevertheless, as further explained by Secretary Rice, they would represent horizontal divisions of the country rather than vertical and would be nation-wide in their membership.

DEVELOPMENT OF THE SOCIETY'S PUBLICATIONS

Next in order were three resolutions introduced by G. K. Parsons, relating to the Society's publications, as follows:

16. RESOLVED: that MECHANICAL ENGINEERING (The Journal) be made a weekly publication at the earliest possible date, and that the Committee on Publications and Papers be encouraged to publish matter of broader scope, including papers and articles that have not been presented at any meeting of this Society, news items of engineering interest, and the information of general interest now presented in Bulletins.
17. RESOLVED: that the Committee on Publications and Papers be requested to study the possibility of a substitute for the present expensive method of publishing the Transactions, presenting any plan developed to the members of the Society for letter ballot.
18. RESOLVED: that the Society publish, as soon as practicable a Handbook of Mechanical Engineering Data.

In introducing these resolutions, Mr. Parsons said they had been carefully worded to apply only "at the earliest possible date" and "as soon as practicable;" and as they were intended for the Council, and through them would be considered by the Publication and Finance Committees, their practicability would be determined by these bodies.

Discussion of Art. 16, Relating to the Development of "Mechanical Engineering" (the Journal). W. E. Symons, Chairman of the Finance Committee, opposed the more frequent publication of MECHANICAL ENGINEERING on the grounds (1) that it would be regarded by other publications as a competitor and that their good-will which we now possessed would then be changed to opposition such as naturally results from commercial competition; and (2) that we would be in a position to suffer a heavy financial loss. He contended that it would be easy to lose a quarter of a million dollars in attempting weekly publication.

R. T. Kent testified to reading MECHANICAL ENGINEERING thoroughly each month; but if issued in the weekly form he felt he would not have time to read it. He disapproved of soliciting contributions for publication except as presented at meetings, as he thought this would bring the Journal in direct competition with the technical press.

L. P. Alford called to the attention of the meeting that the Electrical Engineers had recently passed a resolution asking for the improvement and expansion of their journal and for an increase in its size to the standard 9 by 12 inches; and that a similar resolution was before the Mining Engineers, with prospect of adoption. He took exception to the suggestion that a weekly publication would earn the ill-will of other publishers. He spoke as an editor-publisher and would welcome the upbuilding of the Journal, since whatever was done to advance clean journalism would help his publication. Mr. Alford suggested that Major Fred J. Miller, who had had something to do with the establishment of the Society's Journal and had lately been investigating its possibilities for the future, should give his impressions.

Major Miller, in response, reminded the meeting that the resolutions of the Aims and Organization Committee were made by delegates representing the membership from all parts of the country; that they thought the Journal a good thing and wanted more of it. The qualification "at the earliest possible date," however, indicated that they did not expect the Society to bankrupt itself by making a weekly before it could be done advantageously. He said: "I believe the Journal occupies a field which is distinctive; that is a kind of a journal which no private publisher would probably want to undertake; and that it occupies a field which is not otherwise occupied. A journal either dies of dry rot or it goes ahead and progresses with the progressive ideas of the age and that is what the Mechanical Engineers' journal must do." He then outlined certain definite things which should be done in the development of the publication, such as the extension of the Engineering Survey, by which an engineer can keep in touch with the high lights of his profession without having to read 25 or 30 special journals; and by the strengthening and enlargement of the editorial staff, to permit the gradual enlargement of the Journal and to make it possible for one of the editors to travel and come into personal contact with the membership in different parts of the country.

Following these developments, if the Journal should have grown normally to the point where still more space was needed and the advertising income were sufficient, he could not see how it could become obnoxious to other publishers if it were made a semi-monthly or a weekly, so long as its character were maintained, with the same kind of reading matter and under the same editorial direction. He was in favor of conservatism in the matter, as we were under obligation to be when handling the interests and the money of a professional society such as this. The whole thing could be summed up in so conducting the Journal that it would render the best possible service to the membership.

Mr. Symons, in reply to Major Miller's assertion that there were stages in the life of a journal where it might cease to progress and "die of dry rot," called attention to the marked growth of MECHANICAL ENGINEERING during the past seven years, in circulation, advertising increase, money expended for production for the benefit of the membership, etc. Whereas the publication is very healthy now, he felt that if it were made a weekly it might become very unhealthy from a financial standpoint.

Alex Dow said that MECHANICAL ENGINEERING was one of the few papers which he, a busy man, had time to go through "from cover to cover," and that it was one of the few papers whose make-up and advertising he admired. He wouldn't go through it if it came once a week, and so with many others. And herein, he thought, was a measure of its present advertising value. It is read by the very ones who do not read the weeklies. He therefore

took exception to the point in the resolutions relating to the weekly—it was an error in judgment—and he moved that the words "That MECHANICAL ENGINEERING be made a weekly publication at the earliest possible date" be stricken out. The motion was seconded by W. O. Witherspoon, who said that he was a busy member of several societies and that what was needed was not so much more matter, but a stricter censorship of what was put in their journals.

During the debate on the question of the development of MECHANICAL ENGINEERING the discussion drifted at times upon questions of practicability, in spite of Mr. Parsons' statement in introducing the resolutions that this was a question for the Council and the committees interested to determine. There was also considerable discussion as to expense involved and the utilization of the Society's reserve, details of which W. E. Symons, Chairman of the Finance Committee, contended should be made available so that "anybody who votes in the affirmative or negative on a question of such great and vital importance to the Society should know what he is voting on, expressed in dollars and cents." In the course of this discussion President Cooley, as chairman, asked to have the discussion confined to the general problems involved, as intended by the Committee, saying, "You needn't be afraid the Council will get you into trouble. The Publication Committee will have to come before us with figures, and if the Council is not sure of itself it will come to you again."

In justice to the Publication and Papers Committee, also, it should be told that the sentiment of the meeting with respect to the mission of MECHANICAL ENGINEERING, the field which it is now filling, and its possibilities for development was most favorable. If the members of the Committee who were present were not embarrassed by the many good things which were said, the remarks at least must have been gratifying, as an expression of appreciation of their work.

The motion as amended by Mr. Dow was finally adopted.

Discussion of Article 17, Relating to a Substitute for Transactions. W. C. Brinton, in referring to TRANSACTIONS, discussed also the procedure in handling papers in the Journal. In general, he proposed curtailment in the publication of papers, but that they be issued more completely in loose-leaf form, such copies being announced in the Journal and supplied to the membership as desired. Major Miller called attention to a similar proposal made several years ago, to do away with the bound volumes of TRANSACTIONS and to substitute therefor papers printed in sections. Members would receive the sections of interest to them and not be burdened with the others. The plan had failed—members liked the looks of the bound volumes on their shelves—but it might be proposed again.

Secretary Rice said the Society was under obligations to supply TRANSACTIONS, unless the membership should vote otherwise. In 1893 the membership dues were raised from $10 to $15 a year and it was agreed that if the members would stand for this they should receive TRANSACTIONS in perpetuity. Mr. Rice, however, said the United States is the only country in the world where professional societies have to print the papers read at meetings in pamphlet form; then publish in the proceedings and later in a bound volume. The Society should consider whether it would not reduce this waste and put the money to a more useful purpose. R. T. Kent expressed a desire for the bound volumes, but believed the expense could be reduced, and advised the appointment of a committee to look into the matter. Jesse M. Smith contended that this was a function of the Publication Committee; and further, in respect to the wording of the resolution calling for a letter ballot on the subject, said that the matter could be more effectively handled by having the proper committee report to the Council, they in turn bringing up the report for discussion at a convention. Mr. Kent finally proposed an amendment to Art. 17, substituting for the words "letter ballot" the words "to report at the Annual Meeting." Mr. Smith seconded the motion, which, as modified, was later adopted.

Discussion of Art. 18 on the Publication of a Handbook of Engineering Data. In the discussion of this project it developed that the Committee had no definite plan to offer for a handbook, but that it believed it should be considered in its broad aspects with the possibility that a satisfactory plan would be developed. It was stated by Mr. Parsons, who introduced the resolution, that there was no intention of competing with any of the excellent handbooks now on the market. Following this statement, R. T. Kent said he felt free to discuss the resolution. If the Society were to publish a handbook which would not compete with any of the other handbooks, where is the field for it? What kind of data would it propose to put in? Had the Society considered the expense, which would run into thousands of dollars?

Major Max Toltz favored a handbook which should contain the data gathered by the Society. L. P. Alford said similar data were already published in Condensed Catalogues and thought that these data, with other material added, should go in a handbook. In reply to an inquiry as to the usefulness of Condensed Catalogues, Major Toltz said that in the West, where data readily available in New York are not accessible, the book was in constant use and that "we absolutely need it." Mr. Rice reported that an engineer in Salt Lake City had told him it was "the finest thing the Society gets out."

The resolution as offered was adopted, this and the two preceding as amended, being passed at the conclusion of the discussion.

ABSENCE FROM COMMITTEE WORK

Discussing Art. 19, dealing with absence from committee work, Major Toltz thought that the resolution if adopted and literally carried out would operate as a practical bar to western men serving on committees. Past-President Jesse M. Smith called attention to C-51 of the Constitution, which provides an effective means for removing inactive members from committees. Major Fred J. Miller stated that in his experience with the Society's work it had been very difficult to get action on any specific case of neglect of committee work, and the provision of the resolution therefore seemed to him eminently desirable. Carried.

The resolution in Arts. 20 and 21, on the Society's employment activities, were adopted without discussion.

CODE OF ETHICS

Past-President Charles T. Main opposed the resolution in Art. 22 relating to abolishing the Society's Code of Ethics on the ground that many of the younger members found it of advantage to have a program outlined as a guide for their professional conduct. If it was imperfect it should be revised and amended. Past-President Oberlin Smith spoke in the same strain. Robert Sibley felt that the resolution should be defeated and spoke of the voluntary raising of $20,000 by engineers on the Pacific Coast to put forward a code and carry on education work among engineers in order that it might be put in practice.

Charles E. Lord called attention to the action taken at a recent meeting of the Committee on Development of the American Society of Civil Engineers in Minneapolis, which he attended as a representative of the Committee on Aims and Organization. In line with that action he proposed the following substitute resolution:

> RESOLVED: That it is the sense of this meeting that a short Code of Ethics of broad scope, general character and position rather than negative injunction, be proposed and that the same be enforced vigorously.

Jesse M. Smith approved of Mr. Lord's resolution with the exception of the clause regarding enforcement. There had been exceedingly few infringements on the codes of ethics of the national societies, and it seemed to him that the penalty for infringement should be in the sense of non-recognition by other members rather than expulsion or other forcible action.

Forrest E. Cardullo disagreed with the previous speakers and said that the Society did not need a code of ethics. All that was necessary was that members should be decent, honest men. Codes of ethics were heritages from an earlier day when the condition of the profession and the character of the men practicing them required such formulations.

Wm. T. Magruder then presented the following resolution

which embodied suggestions made by Messrs. Jesse M. Smith, Max Toltz and C. E. Lord:

> RESOLVED: That a committee of five on Code of Ethics be nominated by the President and confirmed by the Council, who shall report back to the Society at the Annual Meeting.

L. P. Alford, on behalf of the Committee on Aims and Organization, withdrew the original motion and those proposed by Messrs. Lord and Magruder were then unanimously adopted.

RELATIONS OF THE MECHANICAL ENGINEER TO THE COMMUNITY

Mr. Lord, chairman of the sub-committee that prepared the articles dealing with the relation of the mechanical engineer to the community (Arts. 23-50), at the suggestion of Mr. Alford read the first eleven articles. The resolutions offered, he said, were practically self-explanatory. The idea presented was one of federalization rather than amalgamation. It was to be clearly understood that there was no desire to change the status of existing engineering societies so far as any technical questions were concerned, but to develop some sort of coöperative agency for dealing more effectively and interestingly with economic, social and political matters. He then told briefly of similar activities on the part of the development committees of the Civil, Mining and Electrical Engineers and asked that Arts. 27-33 be approved.

Frederick H. Low offered the following as a substitute for Arts. 23-33:

> The Society commends the interest taken by its members as individual citizens in municipal, state and national affairs and recognizes that the local engineering societies are the natural and most effective exponents of engineering ideals as applied to public business,
>
> THEREFORE, the Society endorses the policy heretofore pursued by the Committee on Local Sections in conjoining the activities of our Sections with those of the local and state societies;
>
> FURTHER, the Society looks with favor upon and will aid in the formation of a national organization of local societies whereby the voices of engineers as citizens of the United States may have their full value in the discussion of national and international questions.

Alex Dow stated that he believed in one keeping his different expressions of personality through his various affiliations separate. As a member of the Detroit Engineering Society he was not an engineer first but a citizen of Detroit. In the national societies he discussed engineering matters, but in the local society he discussed Detroit from the viewpoint of the engineers of Detroit. He entirely approved of the suggestion made that each member of the Society should be a member of a local society and express in that local body and in the affairs of the community the engineering ideals of truth which we must grow up with. The Society, however, should not undertake to embrace everything that was good, but should say that within its doors men are mechanical engineers first, leaving other matters to be taken up as personal duties in the churches, primaries, caucuses and other organizations of social and political life.

E. S. Carmen said that he could not see that Mr. Low's resolutions differed from the spirit or sentiments expressed in the remarks of Mr. Dow. Resolutions placed it entirely in the hands of the local and coöperating societies to unify the engineering professional work to and for the same high principles of citizenship.

Jesse M. Smith moved that the references to Cleveland, Philadelphia, Minnesota and Ohio in Art. 31 be stricken out, as he thought it was drawing an invidious comparison between the work done in those communities and that done in others. Carried.

Charles E. Gorton thought that the matter under consideration should be referred back to the Committee, to the end that similar committees of the other national engineering societies be consulted and something more tangible be evolved for presentation to the members for their approval.

L. C. Marburg, on behalf of the Committee, explained that the resolutions upon which a vote was asked would not be binding on the Society—they would simply be an expression of opinion as to the general plan. A joint committee had recently been created, consisting of representatives of the four Founder Societies, and at a meeting which it was proposed to hold in July in New York these matters would come up.

W. E. Snyder said it was becoming clearly apparent that the national societies wanted to do their utmost to meet the local societies in some sort of federation and that the resolutions before the meeting indicated a broad and liberal attitude and encouraged local members to attempt and continue the work. To him the original resolutions and Mr. Low's substitute were very similar. It made very little difference what phraseology was used—the spirit of the matter was the thing.

Jesse M. Smith said that he agreed with all that was stated in Arts. 31 and 32, with the exception of the word "independent" in Art. 32. This he thought to be a dangerous inclusion. He took a pardonable pride in recalling that the Local Sections of the Society were created in 1910 when he was its president. He had always stood for their development, but was fearful that it had been pushed too rapidly. Coöperation among the national societies was a most admirable thing and it pointed toward bringing all the societies together. He had outlined his views in this respect at the 1918 Annual Meeting, and in his address when installed as president in 1909 would be found the nucleus of what they were trying to bring about today. He was in hearty accord with Mr. Low's substitute resolutions, because they presented the substance of the Committee's views and yet avoided certain specific points which seemed to him dangerous.

W. E. Symons felt that the purpose of the resolutions as offered by the Committee was splendid. He was not, however, in accord with the method proposed for securing the objects sought, but was fully so with respect to Mr. Low's amendment. He could assure one of the previous speakers that any action taken on the resolutions before them would not be final, for a business meeting was not the Society's court of ultimate resort. The fundamental principles embodied in the Committee's resolutions were rather general in character and if later enacted into law and put into effect serious complications might arise. The cautions brought to their attention by Messrs. Smith and Dow and embodied in the amendment were timely, he thought, and should be heeded.

D. Robert Yarnall, while not sharing Mr. Smith's apprehension that the Sections were progressing too rapidly, felt nevertheless that in view of the fact that the resolutions offered by Mr. Low embodied the spirit of the Committee's presentment, the Committee might graciously accept them and thus avoid the dangers pointed out by Mr. Dow and Mr. Smith. He would therefore support Mr. Low's resolution.

Fred R. Low, who had earlier been called to the chair, took the floor and said that the idea of engineers coöperating was nothing new. The very plan referred to in the committee's resolutions had been in successful operation for years. One of the speakers who preceded him had said that there was a feeling in the Middle West that the national societies wanted to swallow up the local and state societies and that they were operated as a few men in the East wanted them to be operated. He did not believe that engineers in general had that feeling but that they had full confidence in the national headquarters of the Society. The Committee's proposal expressed from headquarters the sentiment that the Society wanted to encourage the local societies to incorporate all engineers within their local groups and devise some plan whereby a definite connection might be established between the locals, the large general local, and the national society, both technically and civically. There was nothing to fear, for at most, affirmative action on the committee's resolutions would be nothing more than a recommendation.

S. F. Jeter agreed with Mr. Smith that there was danger to be apprehended from the inclusion of the word "independent" in the resolution of Art. 32. An additional source of danger was the phrase "fully empowered to act." He could not see how a joint committee of all the societies in which mechanical engineers would have a one-to-three representation would be just and proper in the determination of questions strictly mechanical.

S. N. Castle said that there were at least 100,000 professional engineers in the country, 30 per cent of whom, barring duplications, are to be found in the national societies. The work of the

engineer, as he saw it, falls in two distant branches, his professional work and his work as a citizen, and to coördinate these two fundamental duties a working tool is needed. The spirit of the times was specifically for a formation from the ground up, comprising the purely local societies. From these a grouping into either state, geographical, social, economic or industrial divisions could be made. It seemed to him essential that with the present formation the highly desirable thing to do was to secure coordination between the local societies which handle primarily the community work, and the national societies which handle very largely professional work.

L. P. Alford, referring to Mr. Jeter's objection to the inclusion of the words "empowered to act" in Art. 32, said that the meeting the day before had definitely declared for an attitude of activity in indorsing the resolution in Art. 2 dealing with the adoption of standards.

In regard to coöperation, which, as he understood it, was the real meat of Mr. Low's resolution, it was not only the spirit of the times but, he believed, that of the majority of the Society's membership. Unwillingness to coöperate in the past had led in a number of instances to the withdrawal of members to form societies devoted to special branches of mechanical engineering, and many of the men thus lost were possessed of power and leadership. As he saw it, the issue was clean-cut. It was either to encourage the local organizations and reach out in the spirit of coöperation to other societies, or to stand pat and undoubtedly lose the advantages of other increases in membership which might have been had. He fully believed that the movement for coöperation was so strong that even rejection of the Committee's resolution could not kill it. The same movement was taking place in the other national societies and they were ready to go forward with the A. S. M. E. Was the latter to be the only society which would refuse to coöperate? Would it be the only one on the outside?

The Chairman then put to vote the motion to substitute the resolution offered by Mr. Low for Arts. 30-33 as submitted by the Committee, which was lost. The question of adopting the Committee's resolution was then taken up, but before a vote was taken, Jesse M. Smith moved to amend Art. 32 by striking from the last sentence the words "independent" and "fully empowered to act and." This motion being seconded, the amended resolution was adopted by vote.

Election of Officers

The resolution in Art. 50 was approved without discussion.

Art. 54 recommended that the Regular Nominating Committee, which as prescribed in the Constitution, is to be elected annually by the voting membership of the Society, should be composed of a member from each Local Section, each voting member of the Society being assigned to some Local Section by the Committee on Local Sections exclusively for the purpose of electing a Nominating Committee member. Robert Sibley criticized this resolution on the ground that a committee so composed would consist of too many members to be able to dispatch business adequately and secure harmonious results, and suggested reducing the membership of the Nominating Committee by dividing the country into a grouping of sections and that these groups nominate a committee of five. Such an arrangement, Jesse M. Smith argued, would create a condition whereby the Sections would be unequally represented because it would give the same representation to everyone of the Sections regardless of the number of members of the Society who might constitute it. To this objection Robert Sibley, and subsequently Louis C. Marburg, John J. Simmonds, Lawrence W. Wallace, H. John O. Hinchey and several other members, answered by observing that the Society being a national organization, it appeared to them more convenient to divide it into geographical groups for the purpose of representation in the Nominating Committee than to create the impression that its activities were being conducted principally for the benefit of those members who are residents in the localities where the greatest membership is at present found.

Secretary Rice observed that the provisions for selecting and organizing the nominating committees have not been written as yet in the By-Laws, and in this connection Jesse M. Smith said that the various views brought out during the discussion would enlighten the Committee on Constitution and By-Laws as to the sense of the membership in the manner of carrying out the constitutional amendments just adopted by letter ballot. No modification to the text of the resolution was proposed. President Cooley said in conclusion that although the subject had not been exhausted the discussion had been carried far enough so that the Committee on Aims and Organization could revise its recommendation to the Council.

The recommendation in Art. 55 requesting the Committee on Constitution and By-Laws to prepare such changes in the procedure for the annual election of officers as would permit the declaration of their election by November 1, was favorably commented upon by President Cooley, who expressed the opinion that such provision, if carried out, would permit a president to be coached in his duties before he actually assumed office, in which event the work could go on much more continuously and much more effectively. Jesse M. Smith spoke on the advisability of notifying the President of his nomination as early as possible, even at the Spring Meeting, and moved to substitute for "November 1" the words "a considerable time, to be determined by the Council." The motion was carried.

No changes were made in Art. 56, which was adopted in its original form as drafted by the Committee.

Following the acceptance of Art. 56 L. C. Marburg observed that as several of the resolutions which had been discussed and approved would call for constitutional amendments he would like to submit the following proposals. C-49 now reading:

C-49 Professional Committees:—The Council has the power to appoint, upon the recommendation of the Society at a general meeting, or upon its own initiative, such professional committees as it may deem desirable to investigate, consider and report upon subjects of engineering interests, but shall not be approved or adopted as the action of the Society. Any proposed expenses of such committees must be authorized by the Council before they are incurred.

To be amended to read as follows:

C-49 Professional Committees: The Council shall have power to appoint, upon recommendation of the Society at a general meeting or upon its own initiative, such professional committees as it may deem desirable to investigate, consider and report upon subjects of engineering interest. And proposed expenditures of this committee must be authorized by the Council before they are incurred. Reports of such committees may be accepted by the Society and printed in the TRANSACTIONS.

C-50 The Society may approve or adopt any standard formula or engineering practice, but shall not approve any engineering or commercial enterprises. It shall not consent to the use of its name or initials in any commercial work or business, except to indicate conformity with its standards or recommend practices.

This proposed C-50 would supersede the present C-56.

C-45 *to be amended by adding* "Committee on Professional Sections" *and changing the sentence* "The Chairman of each Standing Committee of Administration shall have a seat in the Council....." so it would read: "The Chairman of all Standing Committees shall have a seat in the Council....."

C-50, reading at the present time as follows: "Each committee shall perform the duties required of it in the By-Laws or assigned to it by the Council; the Secretary of the Society shall be the Secretary of each of the standing committees," *to be amended by adding after the first sentence the following:* "Membership on the Council or any committee of the Society shall terminate automatically on account of absence of any member, either willful or due to force of circumstances, as provided in the By-Laws."

The last amendment elicited much discussion and some members considered its operation would deprive the Society of important and valuable membership on committees on the part of those whose names and prestige would make it desirable that they should serve even though their geographical position would not permit them to attend every meeting.

CRUDE-OIL MOTORS vs. STEAM ENGINES IN MARINE PRACTICE

BY J. W. MORTON[1], PHILADELPHIA, PA.

This paper is devoted to a discussion of the various factors to be considered in choosing the form of motive power for war vessels and cargo ships; also to a presentation of the advantages and disadvantages, as compared to steam engines, of crude-oil motors of the following types: constant-pressure, constant-volume, four-stroke cycle and two-stroke cycle. In the complete paper there will be found a description of some of the details of motor construction, dealing with lubricating systems, piston cooling and scavenging pumps.

THE number of articles which have appeared of late describing the performances of the so-called motorships would seem to indicate that for marine purposes the crude-oil motor is rapidly replacing the steam engine. The chief reason for this is not to be found, as might be expected, in the lower operating cost of the crude-oil motor but is rather due to other factors which when considered lead to the conclusions that it is probably the most economical prime mover of today.

Perhaps the correctness of this statement can best be shown by comparing a steamship with a motorship. In the case of a war vessel, for instance, there are eight factors which ought to be considered in choosing the form of motive power, namely, weight, space occupied, radius of operation, preparedness, crew necessary, fuel, auxiliary equipment, and cost.

The weight of the power plant is of great importance, for a saving therein can be utilized to increase the armor of the ship. If for example, a warship of 3500 tons displacement or equipped with crude-oil motors there would result a saving as indicated by Table 1 which is based on a single steam engine developing 4400 hp. and 3 units of 1600 hp. each of a standard make of crude oil motor.

TABLE 1 COMPARATIVE WEIGHTS OF POWER PLANTS IN STEAMSHIP AND MOTORSHIP

	Steamship	Motorship	Saving in Motorship	
			Wight Tons	Per Cent
Engines, tons	335	264	71	
Per cent of displacement	9.6	7.5		2.1
Fuel, tons	246	86	160	
Per cent of displacement	7.0	2.5		4.5
Crew, Provision, Water, tons	91	82	9	
Per cent of displacement	2.6	2.3		.03
Totals	672	432	240	6.9

In the case cited about the same space would be required for both motor plant and steam plant, but the total horsepower could just as well be developed by two units of slightly larger size, and if this were done approximately one-third the space would be saved. Moreover if oil motors were used the space occupied by the coal bunkers could be partially released, as crude oil can be stored in tanks under the engine floor and below the protective line.

It is obvious that a warship must possess a great cruising radius and if weight for weight of engines be considered then the ratio R of the cruising radii of a steamship and a motorship be expressed by the formula:

$$R = \frac{V_c \times H_o \times W_c}{V_o \times H_c \times W_o}$$

where V_c = cu. ft. occupied per ton of coal = 45
V_o = cu. ft. occupied per ton of oil = 35
H_c = B.t.u. per lb. of coal = 12,500
H_o = B.t.u. per lb. of oil = 18,000
W_c = Lb. coal consumed per e.hp-hr.
W_o = Lb. fuel oil consumed per e.hp-hr.

In the case of the warship under consideration if W_c be taken as 2 and W_o as 0.5 then the ratio will be

$$R = \frac{45 \times 18000 \times 2}{34 \times 12500 \times 0.5} = 7.4$$

The cruising radius will of course vary according to the type of engine and ship, but nevertheless the average ratio as expressed above may be taken at least as 1 to 5 in favor of the crude-oil motor.

A motorship in sharp contrast to the steamship is always ready for action, as no time is lost in getting up steam. Moreover, fuel is consumed only when the motors are running, and the motorship is capable of maintaining full speed as long as there is a supply of fuel.

As there is no need for stokers on a motorship, the crew can be decreased about 10 per cent and this of course permits of a corresponding saving in provision, water storage and quarters.

In the case of a steam-driven warship the smoke from the stack frequently betrays the location of the ship, for it is well known that a vessel can be easily located by its smoke long before the masts or hulls are in sight. Another drawback to the steam-driven warship lies in the fact that the smoke covers the ship with a film of soot which, getting into vital parts of auxiliary machinery, necessitates frequent cleaning and unnecessary wear and tear. On the other hand, when oil is used there is no smoke, the handling of the oil is both cleaner and easier, and the life of machinery and equipment is greatly increased.

When a change is made from steam to oil the auxiliary machinery is usually electrically driven, as this has been found to be the most satisfactory. The dynamos are usually driven by separate oil engines. Hot water for heating and sanitary purposes is obtained from a small oil-fired boiler and while the first costs of such installations are high, they are in time offset by the lower operating costs.

Prior to the war the first cost of a crude-oil motor plant was approximately twice that of a steam plant. This was partly offset, however, by the savings in operating expenses, under which item comes cost of fuel, labor and supplies. The cost of fuel naturally depends upon the prevailing market for coal and oil. In regard to maintenance there is practically no information available as the crude-oil motor is still in its infancy so far as this country is concerned.

Cargo Ships

Many of the preceding statements concerning the installation of crude-oil motors on battleships can also be properly applied to cargo ships. During the last four years a number of such vessels have been equipped with crude-oil motors of both the two-stroke and four-stroke cycle type, and while engineers are not agreed as to the best type, the four-stroke cycle seems to be preferred.

One of the most successful installations of this kind is that found on the motorship *Suecia*. This ship has a length of 362 ft., a beam of 51 ft. 3 in., a depth of 25 ft. 6 in., and a capacity of 6550 deadweight tons, has twin screws driven by two 1000-hp. Diesel engines of the 8-cylinder 4-cycle type, and also two auxiliary engines of 200 hp. each. The vessel was built for service between Sweden and La Plata and its first run was a test made on December 4, 1913. The curves in Fig. 1 give some idea of the characteristics of the motors. The dotted curves are given for the sake of a comparison with the steamship *Princessan Ingeborg* built two years before the *Suecia* and for the same company. The

[1] Asst. Engineeer, Diesel Engine Unit, U. S. Shipping Board, Philadelphia, Pa.

Presented at the Spring Meeting, Detroit, June 16 to 19, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal cost. All papers are subject to revision.

Princessan Ingeborg has a length of 300 ft., a beam of 48 ft. 9 in., a depth of 22 ft. 4 in., and a capacity of 5895 deadweight tons. The coefficient for the *Suecia* is 0.78 and for the *Princessan Ingeborg* 0.794 and thus both vessels are about equal in size and excellence. A comparison will show that the same amount of power is necessary to obtain equal speeds when the displacement are equal. This would seem to indicate that there is no difference between transmitting power through two small comparatively fast-running screws as is done on the motorship and transmitting power through a single slow-running screw as in the case of the steamship. The propeller on the steamship has a diameter of 17 ft. while those of the motorship are only 10 ft. The ratio of indicated to effective horsepower is, therefore, the same for both ships and the total efficiency of engines and propellers is also about the same.

In order to correspond to the motorship in horsepower the

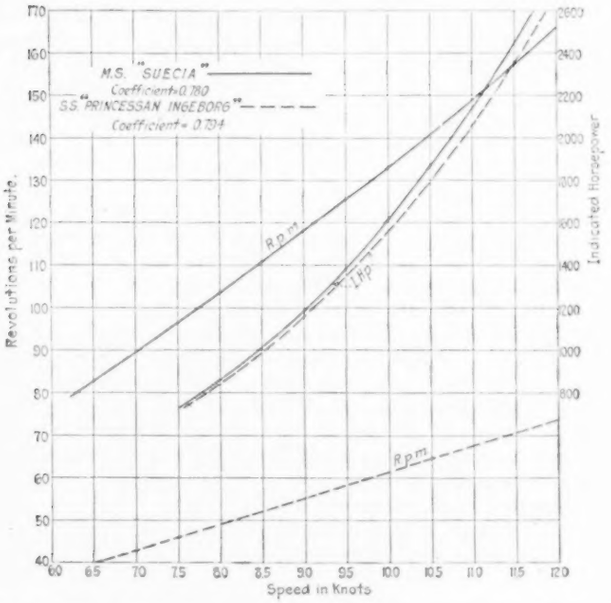


FIG. 1 MOTOR PERFORMANCE CURVES OF STEAMSHIP AND MOTORSHIP

steamship would be obliged to carry an extra boiler. This would increase its weight 570 tons whereas the weight of the machinery on the motorship is only 470 tons. The length of the engine room of the motorship is 41 ft. while the length of engine room and necessary boilers in the steamship is 66 ft. and this despite the fact that the steamship has less horsepower.

The fuel consumption during the trial trip of the *Suecia* was 0.2948 lb. per i.hp. or 0.3685 lb. taking the mechanical efficiency at 80 per cent, a very satisfactory value. Table 2 affords a comparison of this vessel with other motorships.

MOTOR SIZES AND TYPES

The horsepower of a crude-oil motor, whether of the constant-volume or constant-pressure type, is somewhat limited by practical considerations of construction. At the present time the maximum size is 2500 hp. per shaft and from six to eight cylinders for the two- and four-stroke cycle constant-pressure type, although some experimental motors have been built as large as 6000 hp. This is in sharp contrast, however, to the power developed by steam, which runs as high as 15,000 hp. for the steam engine and 35,000 hp. for the steam turbine.

Crude-oil motors of small horsepower are usually of the high-pressure type, intermediate, so-called semi-Diesel or hot-bulb type and two-cycle constant-volume type. Prominent among such semi-Diesel motors are the Bolinder, Scandia, Abance, Alliance, Tuxhan, Gidion and Holm.

It has been proven both by experiment and practice that the constant-volume high-power single-cylinder type of motor is unsatisfactory, and chiefly because of the fact that the enormous heat generated at the pistons during the explosion must travel a great distance before it is transferred to the water jacket; and as a result the central part of the piston is heated to such an extent that preignition frequently occurs. Furthermore, the sudden rise in pressure sets up detrimental vibrating stresses in the material, and it is also exceedingly difficult to obtain a proper mixture of air and oil, rapid ignition and complete combustion and exhaust.

On the other hand, the constant-pressure oil motor of high power must have numerous cylinders all of the same size, and the high pressure, which lasts approximately 10 per cent of the stroke, necessitates a careful design of the crank mechanism. This applies especially to the crankshaft which is both difficult and costly to produce. Moreover, in motors with only a few cylinders the flywheel must be heavy, large and expensive if there is a great variation in speed. Difficulties have also been encountered in keeping the piston leakproof: if it fits too tightly the result is a large frictional loss, and if the clearance is too great there will be a loss of pressure. The greater the piston area the more effective must be the cooling system as the surface exposed per pound of working medium decreases as the cylinder dimensions increase. This accounts for the lower thermal efficiency and the horsepower available per unit of piston surface with large cylinder size.

LOW-POWER MOTORS

Advantages. The efficiency of an oil motor is greater than that of a steam engine, especially in small units, and furthermore it decreases less with increasing load. The fuel consumption of an oil motor is independent of the attendants' skill, as it shows the same value in daily work as on a test stand. With a steam engine, however, the fuel consumption is dependent upon the attendants, and especially the stokers, who must be experienced.

In steam plants the boilers and pipes must be able to withstand high pressures and temperatures, but with oil motors a high pressure exists only in the cylinder and a few small pipes. Moreover, the oil motor is simpler in construction and the weight and space occupied considerably less. It is of interest to note in this connection that the steam turbines in torpedo boats weigh about 45 lb. per b.hp. and aeroplane motors but little over 1 lb. per b.hp.

The small oil motor has other advantages over the steam engine and these can be briefly enumerated as follows: Starting takes only a few seconds; fuel is consumed only during operation; combustion in the motor cylinders can take place for a long period of time; the motors require little attention and the oil tanks can be refilled more easily than coal bunkers and without the dirt which accompanies the latter procedure.

Disadvantages. It must not be thought that oil motors have no disadvantages, for there are many, and chief among them may be mentioned the following: Fuel oil is more expensive than coal and is not available in all ports; furthermore, lubricating oil consumption is greater than in the case of steam engines as one must deal with higher temperatures and, as a rule, higher pressures. The operation of a crude-oil motor is also more irregular than that of a steam engine as oil motors cannot be run as slowly as is desirable when reversing from ahead to astern. The causes of interruptions (especially with electrical ignition) are often difficult to locate; the motor frequently works noisily with smoking and malodorous exhaust; the danger due to fire and explosion is greater, and the life of the machine is considerably less.

HIGH-POWER MOTORS

Advantages. The statements made in regard to the low-power crude-oil motor are also true to a certain extent in the case of the high-powered, but in addition the following items should be noted: With larger output the economy of a power plant becomes of greater importance. The low efficiency of most steam plants is due to the fact that the heat generated must travel through heavy boiler plates, and that there is a great loss of heat through exhaust, and condensation of steam. Furthermore, the steam plant operates with a small temperature difference which ought not to be increased because it is very desirable to work with

high temperature limits. With saturated steam the pressure soon increases beyond a practical value, and with superheated steam the walls of the superheater soon reach their limit as they should never be allowed to become red-hot. On the other hand, in the oil motor the heat formation and utilization take place in the working cylinders, and the high temperature limit is therefore the same as the temperature of combustion. The value of the lower temperature limit is greater than in a case of a steam plant, but the heat difference of the process is higher.

Another advantage of the oil motor is due to the ease with which the air supply necessary for complete combustion is regulated, and since the point of ignition is practically constant, there results complete combustion. On account of the great heat which exists in a boiler room it is very difficult for the stokers to maintain normal pressure; the coal consumption is accordingly increased but the speed of the vessel decreases. On the other hand, in the case of the motorship the reverse holds true. If the fuel oil becomes warmer it is more easily vaporized, with the result that fuel consumption decreases while the speed of the vessel increases.

Since fuel oil can be stored in tanks a considerable saving can be made in space, more oil can be carried and a greater cruising radius thus afforded. The weight of a slow-running four-cycle stroke oil motor for a cargo ship is about the same as that of a steam plant, but far less space is required. The horsepower and speed are about the same for a twin-screw motorship as for a single-screw steamship, but as the former's screw diameters are smaller its efficiency is greater and the vessel can thus be more easily maneuvered. The cylinders of a motorship are all similar, and since they work independent of each other, one or more of them can be put out of service and the motor still continue to operate.

Steam boilers and their fittings require as a rule a considerable outlay for repairs and maintenance; also the sides and bottom plates of the hull which are nearest to the coal bunkers are likely to corrode because of the sulphur content of the coal and in addition sea water in the ballast tanks may also cause corrosion of the plates. On the other hand, a motorship has no boilers and the fuel is stored in bottom tanks and this very fact is a great advantage since such tanks are protected by the oil.

Disadvantages. In a case of a single-cylinder oil motor the torque acting on a single shaft is limited but, everything else being equal, such as shape and line of hulls, propellers, r.p.m. and b.hp., the indicated hp. of the motorship will be greater than that of the steamship.

Since the reciprocating parts in a crude-oil motor weigh more than those of a steam engine the balancing of the masses is more difficult and the shifting forces greater. At light loads the pistons in a large motor are not tight enough to maintain high compression and since the combustion space is not sufficiently warm for positive self-ignition, large motors can only be run when under light loads at approximately one-third to one-fourth normal speed. Furthermore, the heat transmitted to the cooling water per unit area of the cylinder is about 2½ times as great in a combustion chamber as in the cylinder walls, accordingly the heat drop in the cylinder wall is very considerable and tends to introduce stresses in the material, and if the limits of the elasticity are exceeded these stresses will be transmitted to distant parts. The material is also subjected to high stresses as a result of the rapidly repeated power impulses, the high temperatures, and great pressure in the cylinder.

TABLE 2 DATA ON VARIOUS CARGO MOTORSHIPS

(Number of main motors on each ship=2)

Name of Ship	Year placed in service	Owner	Hull					Machinery							
			Length ft.-in.	Beam, ft.-in.	Depth, ft.-in.	Capacity, deadweight tons	Speed in knots	Total i.hp.	No. of cylinders in each motor	Bore, mm.	Stroke, mm.	R. p. m.	Ratio of Stroke to bore	Piston speed, meters per min.	M. e. p., kg. per sq. cm.
Suecia	1912	Nordstjernan	362-0	51-3	25-6	6550	10¾	2000	8	500	660	140	1.32	185	6.2
Selandia*	1912	East Asiatic Co.	370-0	53-0	30-0	7400	12	2500	8	530	730	140	1.38	204	6.2
Pedro Christophersen	1913	Nordstjernan	362-0	51-3	25-6	6550	10¾	2000	8	500	660	140	1.32	185	6.2
Siam	1913	East Asiatic Co.	410-0	55-0	30-6	9700	11¼	3000	8	590	800	125	1.36	200	6.2
Annam	1913	East Asiatic Co.	410-0	55-0	30-6	9700	11¼	3000	8	590	800	125	1.36	200	6.2
Kronprins Gust. Adolf	1914	Nordstjernan	362-0	51-3	25-6	6550	10¾	2000	6	540	730	140	1.35	204	6.4
California	1913	United Steamship Co.	405-0	54-0	35-0	7250	11¼	2600	8	540	730	140	1.35	204	6.2
Kronsan Margareta	1914	Nordstjernan	362-0	51-3	25-6	6550	10¾	2000	6	540	730	140	1.35	204	6.4
Fionia*	1914	East Asiatic Co.	395-0	53-0	30-0	6700	13½	4000	6	740	1100	100	1.49	220	6.34
Malakka	1914	East Asiatic Co.	410-0	55-0	30-6	9200	11¼	3100	6	630	960	125	1.525	240	6.2
Tongking	1914	East Asiatic Co.	410-0	55-0	30-6	9200	11¼	3100	6	630	960	125	1.525	240	6.2
Pacific	1914	Nordstjernan	362-0	51-3	25-6	6550	10¾	2000	6	540	730	140	1.35	204	6.4
San Francisco	1915	Nordstjernan	362-0	51-3	25-6	6550	10¾	2000	6	540	730	140	1.35	204	6.4
Panama	1915	East Asiatic Co.	410-0	55-0	30-6	9200	11¼	3100	6	630	960	125	1.525	240	6.2
Australien	1915	East Asiatic Co.	410-0	55-0	30-6	9200	11¼	3100	6	630	960	125	1.525	240	6.2
Columbia	1915	East Asiatic Co.	425-0	55-0	30-6	9500	11.15	3100	6	630	960	125	1.525	240	6.2
Chile	1915	East Asiatic Co.	425-0	55-0	30-6	9500	11.15	3100	6	630	960	125	1.525	240	6.2
Oregon	1915	United Steamship Co.	405-0	54-0	36-6	8270	11.0	2800	6	590	900	140	1.525	252	6.1
Peru	1916	East Asiatic Co.	425-0	55-0	30-6	9500	11.15	3100	6	630	960	125	1.525	240	6.2
														(Avg.)	6.24

*Cargo and passenger vessel.

CONSTANT-PRESSURE MOTORS

Low-Pressure Types. The low-pressure oil motor is perhaps the simplest prime mover of its kind and is especially adapted for use in small boats where the operators are usually unskilled. The chief advantages of this type of motor are its low first cost and small operating expenses. Furthermore, the low temperature in the cylinder and the low explosion pressure together with its simplicity of operation make it a motor of great durability. This type, however, has some disadvantages and chief among them are its small power output, large cylinder dimensions, excessive weight and long time required for starting.

Hot-Bulb Type. The so-called hot-bulb motor operates at a medium pressure, with or without water injection. While the tendency today is to avoid water injection, if the hot-bulb motor be nevertheless operated with water injection its fuel consumption will be comparatively low; the temperature of inlet air low; overheating of cylinder and piston will seldom occur; the cylinder will

remain clean for a longer period and the piston rings will not gum or stick. The water tank, however, takes room, adds weight and considerably reduces cargo space. Furthermore, despite careful attention, corrosion and rust will rapidly destroy the motor, especially if sea water is used. The most serious objection, however, lies in the fact that the amount of water injected must be regulated according to load and this necessitates constant attention.

On the other hand, if the intermediate-pressure motor is operated without water injection, the cost of maintenance is low, the mechanism construction simple and little attention is necessary. Its chief operating difficulty lies in the inability to properly time the supply of fuel oil as its injection against the highly compressed air is exceedingly difficult in the short time allowed before ignition takes place.

High-Pressure Type. The advantages of high-pressure motors with self-ignition and injection of fuel oil during the high-compression cycle are practically the same as those of the intermediate-pressure motor without water injection. High-pressure motors, however, are usually operated with an oil chamber and such a type is very economical, has a high mean effective pressure, its cylinders are small, its weight low and it can be started without any preliminary operations. Furthermore, since the fuel oil is not injected against a high pressure the fuel-oil pumps can be of simple design and consequently easily maintained. Like all other motors, however, this type also has its disadvantages, chiefly the fault of design and construction rather than operation. If the size of the oil chambers or atomizer holes be improperly proportioned, fuel-oil consumption will greatly increase. Since this type of motor cannot be started by hand pressure air is therefore necessary and consequently the motor must be manufactured with great care. This of course means a higher initial cost. In operation, the ignition and combustion cannot always be controlled and especially if inefficiently operated preignition will occur.

Four-Stroke-Cycle Motors

Advantages. This type of motor is particularly well-adapted to high-speed work since it has a separate suction and exhaust stroke and thus the cylinder is filled each time with a full and new charge. Compared to a corresponding two-stroke motor it uses less fuel per brake horsepower. Furthermore, it does not employ a scavenging pump, receivers, etc., and the motor construction is therefore simplified and better adopted for continuous hard work.

Disadvantages. The chief objections to this type of motor are its increased weight and the greater space required. On account of the increased number of valves the valve gear is more complicated and noisy. Except with very large output the piston can act as a crosshead and unless the cylinder diameter be greater than 20 in., water cooling is unnecessary. The crank motion of this type of motor necessitates a heavy crankshaft and heavy flywheel if smooth running is to be obtained. Furthermore, the exhaust valves are subjected to high temperatures and occasionally give rise to considerable trouble. This type of motor is exclusively used for the Danish and Dutch merchant marine and also finds a large field in the automobile and aeroplane industry as gasoline and gas engines work as a rule in the four-stroke cycle.

Two-Stroke-Cycle Motors

Advantages. Compared with a four-stroke motor a two-stroke-cycle motor has a greater output per cylinder and everything else being equal, this will usually be about 75 per cent. On account of its greater pressure at the beginning of the compression stroke the weight of the charge can be increased if the stroke volumes are equal. On the other hand, the power is exerted only during three-quarters of the stroke as during the remaining portion exhaust takes place. Thus the total stroke volume is not completely filled at the beginning of compression with a fresh charge, and the result is that for the same cylinder dimensions the output is only 75 per cent greater than for a four-stroke motor. This difference, however, becomes even less for high-speed two-stroke motors since the mean effective pressure is lower. By forced scavenging through the valves the fresh air charge can, however, be made cleaner. In large units only the starting and fuel valves are subjected to high temperatures. In the open-type four-stroke motor, vapor from lubricating oil and exhaust gases can escape into the engine room, thereby causing impure air conditions. This, however, does not occur in a two-stroke motor which has a closed crankcase. Finally, the two-stroke engine is very smooth running because of its more uniform torque.

Disadvantages. The chief disadvantage of the two-stroke motor is its high operating cost. This is due to its higher loss of fresh air charge through exhaust parts and smaller utilization of the working fluid and higher heat loss due to cooling friction and increased pump work. The mean effective pressure is lower because during the working stroke exhaust also takes place. The mean temperature during the cycle is higher than in the four-stroke motor and consequently cooling of the piston is necessary. Furthermore, the piston can act as a crosshead only in small motors; lubricating-oil consumption is greater and the exhaust ports become overheated if not water-cooled. Finally, the stresses exerted on the moving parts are very large and therefore there must be ample sliding and bearing surface. The two-stroke type of motor is chiefly used in vessels where weight, space and first cost are the deciding factors. Its reliability and economy, however, have not been so marked as in the case of the four-stroke motor although in the Scandinavian countries, Germany and Italy it has been used to a considerable extent.

Notes

The exigencies of the war and the reconstruction period are forcing narrow-gage railways into engineering notice in England, where many productive areas are still isolated from the centers of consumption. It is urged that the available material for hundreds of miles of the light railway which was developed so effectively in the zone of communications at the front can now be put down in the remote districts of England by the experts who built similar lines in France, without the complicated legal and parliamentary procedure required to put through a standard-gage line and at much lower first cost and operating expense than main-line railways or highways.

An article describing the ventilation plant of the Simplon Tunnels, published in four recent issues of the *Schweizerische-Bauzeitung*, discloses some of the interesting questions which were considered in the determination of the position and the dimensions of the fans. There is only one ventilation plant for the two tunnels. The northern inlet at Brig was selected for the location of the plant, partly because meteorological conditions proved that the barometric pressure is in general higher at this entrance so that less power would be required for maintaining an air current from north to south than in the opposite direction, and partly also by the fact that the whole organization of the tunnel service was concentrated at that town.

The plan of having the current in each tunnel follow the direction of the train motion was not adopted because it had been observed that, when the air was taken in at Iselle, all the iron in the tunnel structure rusted badly. The reason was that the air at the southern entrance, being warmer and more humid, became cooled and deposited its moisture while traveling in the tunnel. In order to reduce the air resistance to a passing train and the power demand on the ventilation plant, the ventilation is shut down during the northward passage of the train.

Each of the two ventilators in the plant is a fan of 11½ ft. external diameter and 5.13 ft. wide, with a central suction opening 8½ ft. in diameter; six parallel rows of buckets, built of wrought-iron blades and partitions, take up 4.1 ft. of the width of the wheel; the hub is of cast iron. Each fan is directly coupled with an asynchronous three-phase motor which is fed with railway current at 3200 volts and a frequency of 16⅔.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of MECHANICAL ENGINEERING by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

How Can Engineers Be of the Greatest Use to Civilization?

TO THE EDITOR:

Engineering depends upon knowledge of facts and upon putting that knowledge into practice.

The exact form that the practice may take is guided by the conditions at the time and place concerned. There may be differences of opinion as to the exact value of those facts because of difficulty in getting perfect measurements, but as to the facts themselves, engineers are agreed.

It does not matter to the engineer whether these facts are found in a book on physics, or natural philosophy, or the first book of science, or whether they are found in an engineer's handbook.

Imagine, if you can, an engineer proposing that the law of gravity for a certain place be established by a vote of the people, or that delegates be appointed who should meet with delegates from other countries to come to a working understanding on a fair and just multiplication table, or that designers should get together and compromise their differences so that the mechanical properties of bodies should be the same in all countries!

There may have been a time when such an attempt could have been made, but if so, it was before there was any general knowledge of the principles upon which engineering is founded.

Many times statements come from engineering sources that engineers do not receive the recognition in the general affairs of the world to which their knowledge and training point. So general are the facts upon which such statements are based that they may be accepted as true, and if they are true there must be a reason for that truth.

Various reasons have been given for this state of affairs, but it has seemed to me that they do not go deep enough to get to the root of the matter.

No man who is educated to the point where he deserves to be called an engineer ever quarrels with the truths, or laws, upon which his profession is founded. In dealing with the circle, for instance, he knows that the diameter and the circumference have a fixed relationship to one another even though he cannot express in figures what this relationship is to absolute correctness, and he knows this, whether he uses 3 1/7 to 1 as the ratio of the circumference to the diameter as being accurate enough for the case in hand, or whether he uses figures which come nearer to the truth.

Even in matters in which the knowledge of the underlying laws is still very incomplete, as with wireless electricity, the engineer never doubts the existence of these laws, and his efforts are always directed to finding them and obeying them, for he is sure that only by so doing can he really succeed.

Knowing so much in his own particular part of the world, how can the engineer avoid the conclusion that the remainder of the universe is founded on just as fixed laws? If he does so conclude, why does he not act in harmony with his conclusions? If he is in doubt in the matter, why does he not investigate in a manner to find the truth?

Is there any evidence that engineers are clearer thinkers in every-day affairs outside of their line of engineering than those who are not engineers? If they are not, why should the public give them a larger part in its affairs? If they are, why does it not show in their position in the affairs in which we all are interested?

In matters such as taxation, one which affects every individual and every community, for instance; or the prohibition of the use of intoxicants; or the choice of candidates for public office; or the enforcement of laws in local affairs; or in the numbers of other things which no one of us can get away from, is the engineer guided by trained reasoning powers which seek out the truth, or is he controlled by his passions, his prejudices and his inherited superstitions, just as are the so-called uneducated?

Unless we, as engineers, can show that our education as engineers does fit us for leadership in these other things, why should the public have any more use for us than it now has?

Of course, it is much more pleasing to think that fault in the matter rests on the public and not on us, but the truth is the thing that will control in this matter, just as it does in engineering matters.

The activities of the members of this Society have gone far beyond our original aims; new boundaries are being thought of and need for a larger vision has been pointed out and a new code for our guidance has been urged. While we are thinking of these things, should we not recognize that all truths are comrades fighting the battles of civilization, whether these truths are religious, political, social or engineering truths, and that all untruth is on the other side, fighting against civilization?

Engineering developed because it sought out, found and accepted things that are the tools of the engineer, and if civilization is to grow and prosper and endure it must rest on a like foundation of truth in all matters that are the tools of civilization.

If the belief that truth of all kinds will finally prevail is not justified, the outlook for the future is surely a dark one. If the belief *is* justified, then honor belongs to those who find and practice truth, and we as a society and as individuals should always be on the side of truth in all of our human activities.

Engineers have numerous handbooks. Go to any of these that you will, and you find that there is perfect agreement in the fundamental principles. If there is any disagreement it is in regard to the best way to apply these principles, but as to the principles themselves there is no disagreement. If any member of any of these engineering societies were to try to start a movement to have a vote taken to adopt something else instead of these foundation principles, he would be expelled and perhaps shut up in an insane asylum; and certainly a person who did not believe in these principles would not be admitted to membership if his beliefs were known.

Why not have handbooks of civilization in which will appear the fundamental truths against which no agitation will be permitted, either under the guise of free speech or under any other form; and if any will persist in working against these truths, why not put him in an insane asylum or deny him the privilege of membership in the society of civilization?

The universe and every atom contained in it is built upon truths, and these truths cannot be altered by any action on our part, but all real progress must be in line with them. Have we vision enough to see this? Have we the courage to look it in the face?

W. O. PLATT.

Oil City, Pa.

Regarding the Society's Employment Service

TO THE EDITOR:

I was greatly interested in reading the Society Affairs Section of MECHANICAL ENGINEERING for May, and particularly in the subject, Some of Our Problems.

I note that under this subject mention is made of the Employment Department and the question raised, Shall we continue Employment Work? It is noted that about 7 per cent of the membership was directly benefited last year, and also that some of the members consider this phase of the Society's activities as undignified.

It occurs to me that the Employment Service Department of

the Society has performed a great service to the membership in the past, and the fact that 7 per cent of the large membership of the Society was actually benefited last year speaks well for this department, and, further, it does not occur to me that this service is in any way undignified.

There usually comes a time at some stage in every man's career when he needs assistance in securing proper and suitable employment connections, and it would appear that when the Society through its Employment Service Department has assisted a worthy and qualified engineer to make such a connection, the Society has performed a twofold service: it has assisted a member in securing employment and at the same time has rendered a service to the firm employing him.

C. T. BAKER.

Atlanta, Ga.

TO THE EDITOR:

I want to take this opportunity to express my appreciation of what the A.S.M.E. has done for me, especially in the last few months.

Through the efforts of the Engineering Societies Employment Bureau I have just obtained a position which looks very promising, and the advertisement which I inserted in the current number of MECHANICAL ENGINEERING has brought me a number of replies.

All this has been without extra charge, and it has occurred to me that this must put a heavy burden on the Society. In order that the efficiency and usefulness of the Society may be maintained at its present high standard, I would gladly pay an increase of 25 to 50 per cent in dues, if that should prove necessary.

R. E. NAUMBERG.

New York, N. Y.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 236-239, inclusive, as formulated at the meeting of May 23, 1919, and approved by the Council. In this report, as previously, the names of inquirers have been omitted.

CASE NO. 236

Inquiry: Is it permissible under the Rules of the Boiler Code to use commercial open-hearth steel pipe for the heating surface of a special small coil boiler, provided not over $\frac{3}{8}$ in. pipe is used? Also is it permissible to use wrought iron or steel lap-welded extra-heavy pipe for the shell of this boiler, provided the diameter does not exceed 12 in.?

Reply: It was not contemplated that the Boiler Code Rules would be applied to miniature boilers. It is the intention of the Code Committee to prepare a set of Rules for such boilers. Until these Rules are issued, the acceptance of miniature boilers for various classes of service will rest with the rulings of those authorities under whose jurisdiction they may come, without guidance by Code Rules.

CASE NO. 237

Inquiry: Is the requirement in Par. 282 of the Boiler Code relative to a lifting device applicable to a $\frac{1}{4}$ in. safety valve designed for operation on miniature boilers? Such a lifting device may be worked out for such a design of small safety valve, but inasmuch as the Rules of the Boiler Code do not apply to valves less than 1 in. in size, it is thought that the lifting device would be unnecessary and undesirable.

Reply: It was not contemplated that the Boiler Code Rules would be applied to attachments for miniature boilers. It is the intention of the Committee to prepare a set of Rules for miniature boilers, and until these Rules are issued, the acceptance of attachments for miniature boilers for various classes of service will rest with the rulings of those authorities under whose jurisdiction they may come, without guidance by Code Rules.

CASE NO. 238

Inquiry: Is it permissible under Par. 291 of the Boiler Code relative to water gage glasses, to use a double set of gage cocks? In other words, will a boiler equipped with two sets of gage cocks meet the requirements of the Code for use in saw mills and similar service in the open where there is no protection from injury to the water glass?

Reply: It is the opinion of the Committee that, while Par. 294 permits of omitting the gage cocks if two water glasses are used, a set of gage cocks may not be substituted for a water glass under the requirements of the Rules of the Boiler Code.

CASE NO. 239

Inquiry: Is it permissible under the requirements of Par. 194 of the Boiler Code which states that for boilers over 48 in. in barrel diameter, a dome shall be placed on the barrel instead of over the firebox, to place the dome over the firebox on a boiler which has a 50 in. wagon top diameter and a 46 in. barrel diameter? Also, may the holding power of the staybolts be added to the strength of the riveting in the dome seam when figuring the factor of safety?

Reply: It is the opinion of the Committee that for a contracted waist type of boiler, where the barrel diameter is within the limits specified in Par. 194 of the Code, it will be permissible to locate the dome over the firebox. It is not permissible to add to the strength of the riveting in the dome seam the holding power of the stays in calculating the factor of safety.

The value of natural gas as an ideal fuel is now universally recognized and the prevention of fuel waste is of urgent importance to the welfare of the Nation. The Bureau of Mines Technical Paper 209, Traps for Saving Gas at Oil Wells, by W. R. Hamilton, pertinently calls the attention of oil operators to the advantages derived from the use of gas traps for separating and saving the gas from the flow and lead lines of oil wells.

The basic principle of gas-trap construction is to arrest the speed of flow in a chamber that separates the gas and oil. Oil and gas enter the top of a container through one bung, and the gas escapes through another at the top: oil flows out the bottom through a U-tube which provides an oil seal and prevents the escape of gas. This fundamental idea has been modified in various forms to provide for special conditions.

In general, traps might be grouped in three types, upright cylindrical, horizontal tubular, and special. Those of the first type are principally used on wells of small capacity; the second type is specially used for large wells of the gusher type; traps of the third type are used under certain special conditions. Mr. Hamilton describes various devices possessing the characteristics of each of these three general types, with a view to enabling the operator to choose one that will be likely to suit his particular need.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

Tarrant Triplane
Superchargers for Aero Engines
Air Coolers for Turbo-Compressors
Inverse Rate Method of Thermal Analysis
Stop Watch, Use in Thermal Analysis
Transformation of Alloy Steel and Rate of Temperature Change
Wire Rope, Strength and Other Properties
White Cast Iron, Graphitization in Annealing
X-ray Examination of Materials
Surge Pressure in Pipe Lines
Spark-Plug Efficiency
Starters for Aircraft Motors
Air-Compressor Lubrication
Tolerances
Milling Tools, Continuous
Statically Indeterminate Structures, Analysis
Slope-Deflection Method
Steam Turbines, Impulse and Reaction, Bucket Efficiency

AERONAUTICS (See also Internal-Combustion Engineering)

Largest Heavier-Than-Air Machine in the World

Tarrant Triplane. Tarrant triplanes, the largest heavier-than-air machines in the world built so far, have been constructed at the Royal Aircraft Establishment at Farnborough. They were designed as bombers and were expected to fly from England to Berlin with a load of sixteen 550-lb. bombs and have a large enough cruising radius to return to England. At present it is the intention to adapt them to commercial flying, as 100 passengers or an equivalent tonnage can be comfortably hoisted within them.

The most distinctive feature of the Tarrant machine is its fuselage, which is made up of a series of braced main rings with lighter rings or formers spaced between, the whole being connected together by a series of longerons running the whole length of the

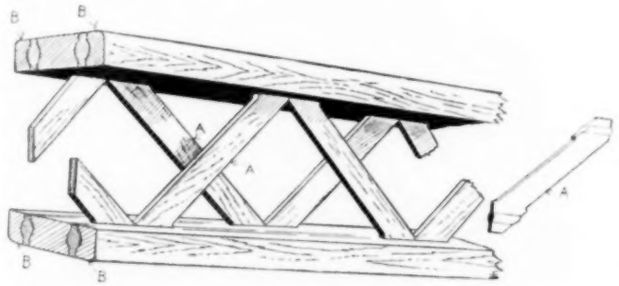


Fig. 1 Tarrant System of Spar Construction

body. These longerons are built up on the Tarrant spar system at the parallel portion of the fuselage and taper down to a single longeron member at the reduced portion. The whole framework is covered by a skin of plywood made of two-ply and varying in thickness upon the different sections of the fuselage.

The machine is fitted with six Napier "Lion" engines, each capable of developing 507 b.hp., and with full load a speed of over 90 m.p.h. can be obtained with two engines cut out.

The basic idea of the construction of the more important members of the Tarrant triplane is an adaptation of the braced girder as used in steel bridge work. Instead, however, of riveting the web bracing to the flanges, the construction shown in Fig. 1 has been adopted. The flanges *BB* consist of grooved pieces of wood which are glued on either side of a series of beaded bracing members *A*, the grooves registering with the beads. It is claimed that in this method of construction there is less chance of faulty timber being worked into the machine, for each piece of the girder is small and can be easily inspected. It is also claimed that the time required for seasoning in the Tarrant method of construction is less than usual, owing to the small size of the pieces. The tremendous size of the machine and the character of the mechanism are indicated by Fig. 2. On the left are shown the tanks, engineers' compartment and cockpit. The pilots, engineers and passengers all enter by the same door and are thus protected from risk of being struck by the propellers. In addition to the tanks shown in the figure there are other tanks arranged overhead, where

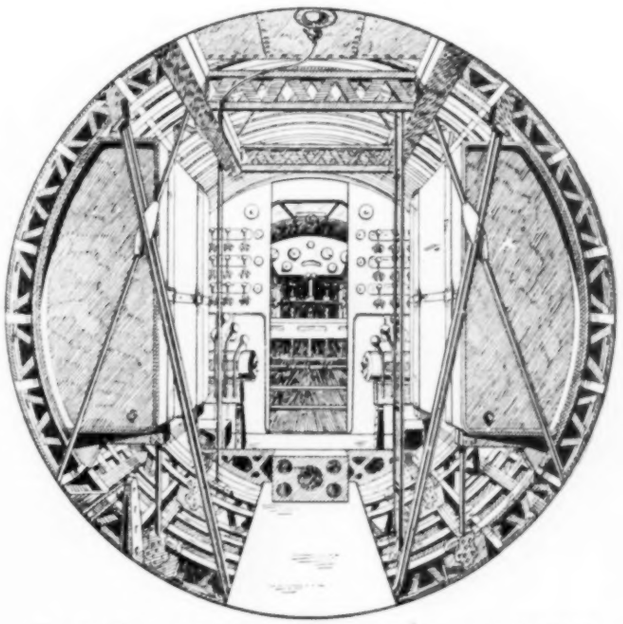


Fig. 2 Tanks, Engineers' Compartment and Cockpit

there is also an exit through which the engineers may climb out so as to reach the engines in case of emergency.

Fig. 3 shows the engineers' dashboard and entrance to cockpit. The two pilots sit side by side and operate duplicate intereconnected controls, in addition to which they have a master control over the engines. For this there are provided a master switch controlling all the ignition circuits and six levers whereby the throttles can be separately adjusted. All other matters connected with the running of the engines are in the hands of the engineers.

The engines are arranged three on each side of the center line and are equipped with the Maybach starting system.

The total weight of the plane with crew, bombs, gasoline and oil is estimated at 44,672 lb. (*The Engineer*, vol. 127, no. 3306, May 9, 1919, pp. 452-454, 10 figs., *dA*)

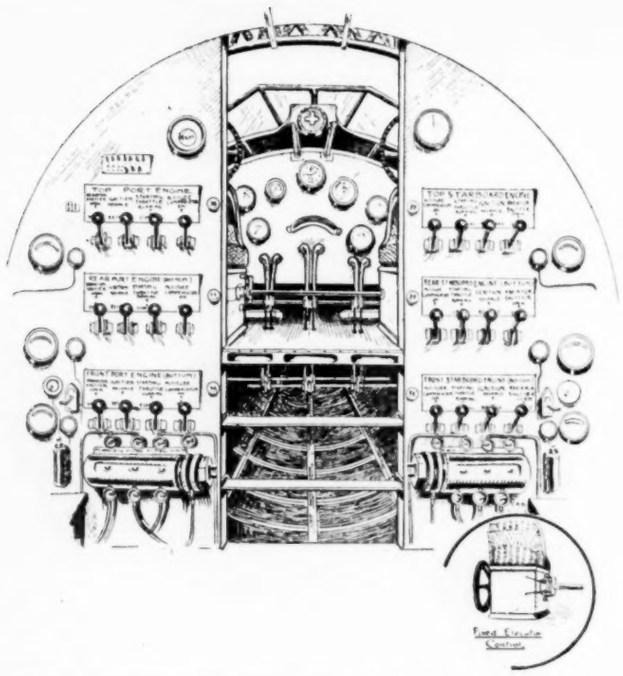


FIG. 3 ENGINEERS' DASHBOARD AND ENTRANCE TO COCKPIT

Moss Supercharger for Airplane Engines

MAINTAINING CONSTANT PRESSURE BEFORE THE CARBURETORS OF AERO ENGINES REGARDLESS OF THEIR ALTITUDE, Leslie V. Spencer. In a previous issue of MECHANICAL ENGINEERING (May, 1919, pp. 476-477) reference was made to superchargers, the aim of which is to maintain a constant content of oxygen in the engine charge regardless of the atmospheric pressure. The

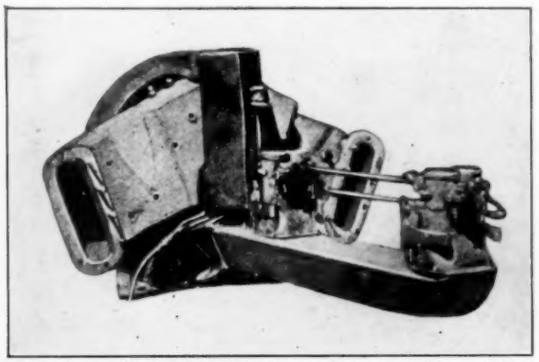


FIG. 4 REAR OF MOSS SUPERCHARGER SHOWING NOZZLE BOX AND INDUCTION SYSTEM

Moss supercharger designed by Dr. Sanford A. Moss, Mem. Am. Soc. M. E., and used on the Liberty-12 belongs to this class of machinery.

In this supercharger the turbine rotor, centrifugal compressor and air impeller are placed on the same shaft and the arrangement is such as to leave the Liberty engine carburetors in the center of the V, connected to the air discharge of the compressor by an induction pipe of generous proportions and rectangular in section.

The engine exhausts are on the outside and the gases are sent to the nozzle box of the turbine by means of substantial, specially designed exhaust headers which connect at their front ends to the flanges on the other side of the nozzle box.

In the Moss machine the nozzles are arranged in a semi-circular plate set into the front side of the nozzle box (compare Fig. 4). This is expected to help in keeping down the temperature of the rotor, since the intense exhaust-gas heat is not being directed to the entire rotor all the time, but to only about one-half of its circumference.

Because of the great fore-and-aft width of the Moss machine it cannot be installed on the Liberty engine with the propeller in its normal position and there has to be used a special propeller flange and hub construction.

A feature of the Moss machine is the water-cooled rear bearing (Fig. 5). A special water jacket surrounds the bearing proper and through it water is circulated from the regular water circulation system of the engine. The machine is also provided with self-aligning bearings to take care of any slight inaccuracy of the position of the rotative parts due to the high speeds and high temperatures encountered in operation.

In confirmation of the precautions taken in the design and the special features incorporated against overheating, the Moss apparatus has never given any appreciable overheating trouble in any operative tests yet conducted. The nozzles, which are subjected to the most severe heating conditions, have shown a slight red color after considerable running, but none of the other parts has become hot enough to reach a visible red. Undoubtedly the successful results obtained in this respect are due largely to the provision for free air circulation around the turbine and an equally free method of exhaust. In the writer's opinion Dr. Moss has been entirely justified in claiming slightly more room at the front of his machine than is allowed by the normal position of the propeller of the Liberty engine, for this permits the design of the apparatus in such a way as to get about as good cooling effects as is possible in the necessarily limited space available. The matter of the heat dissipation is of premier importance in any development work of this nature.

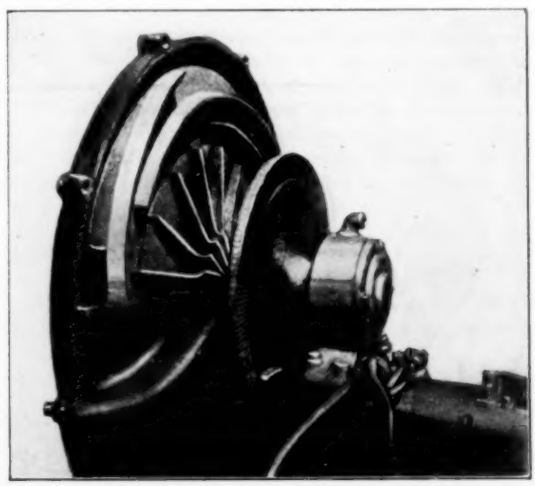


FIG. 5 MOSS TURBINE WHEEL AND WATER-COOLED REAR BEARING

In order to prevent the nozzle box and exhaust manifolds from getting out of shape due to the temperature and the pressure of the gas within, these chambers are internally braced by means of cross-stays which are welded to the casings. This was found necessary due to the fact that the nozzle box must not be allowed to distort to any extent, and in order to maintain a good joint between the nozzle box and the manifold on either side the manifold must be made quite rigid without being heavy. The cross-stays have proved a most satisfactory expedient. (*Aerial Age Weekly*, vol. 9, no. 8, May 5, 1919, pp. 387-389, 4 figs. *dA*)

AIR MACHINERY

Swiss Intercooler for Turbo-Compressors

B. B. C. AIR COOLERS FOR TURBO-COMPRESSORS (*B. B. C. Mitteilungen*, Nov. and Dec., 1918). The present article describes a new (patented) type of cooler for turbo-compressors, manufac-

tured by Brown, Boveri and Co., of Baden, Switzerland, and designed to meet the reduction in the number of cylinders used in the compressor to one. The new device is called an "intercooler," being fitted between the first, second and third groups of rotors of the compressor. The air enters and emerges through special coils so arranged over the groups as not to affect the rotor overall length of the compressor.

The cooling surface of each stage is distributed over two nests of coolers arranged in parallel, which are placed obliquely at both sides of the lower part of the cylinder. This arrangement facilitates cleaning.

The lower parts of the coolers are divided into two parts, which permits of cleaning them while the machine is running; the water chamber of one half can be opened while the other half remains in operation, thus preventing too great a rise in temperature of the successive groups of rotors.

The nests of tubes are generally round, though oval brass tubes are used for heavy loads, in the first and second stages, the tubes being brazed into solid bronze bottoms. The upper bottom plate, with its water chamber, is firmly screwed down to the cylinder, while the end piece of the lower bottom plate is freely movable in a round stuffing box, to allow for expansion of the tubes with temperature.

The cross-sectional area of the air passage between the tubes (the "air gap") is so selected that the heat transmission and pressure drop are at a convenient ratio to the efficiency of the compressor, and the cross-sectional area of the nest assumes a square shape which fills up the round openings in the cylinder as much as possible by omitting the tubes at the corners of the square. This form also permits of the use of round stuffing boxes of minimum diameter.

To compensate for the uneven thermal expansion of single tubes or groups which would give rise to deleterious stresses, the tubes are bent so that each one of them may expand outwards if necessary.

Special distance pieces are fitted to hold the long tubes together and prevent vibration, and other arrangements are provided to eliminate play and displacement of the tubes.

The air and water flow through the tubes on the counterflow principle, i. e., the air outlet and water inlet coincide, the article describing the flow of the two media in the various parts of the cooler.

The tube nests, water chambers and side plates form one unit which can be inserted in the cylinder openings.

The theoretical discussion in connection with the new type of cooler deals with: (1) the transmission of heat and the specific pressure drop; (2) influence of the cooler load on the efficiency of the compressor; (3) comparison of different methods of cooling compressors; and (4) the heat-transmission factors of various types of tubes.

The manufacturers claim that the cooling of their compressors may be said to be satisfactory in all respects, as it provides for the best utilization of the cooling surface by the arrangement of the tubes and by the air velocities and cooler factor obtained. (*Technical Supplement to the Review of the Foreign Press, vol. 3, no. 10, May 13, 1919, no. 5008, pp. 349-350, d*)

BUREAU OF STANDARDS

A SIMPLIFICATION OF THE INVERSE-RATE METHOD FOR THERMAL ANALYSIS, Paul D. Merica. The use of stop watches in taking inverse-rate curves in thermal analysis is described, and it is shown that they may be substituted for the chronograph, which is often used without sacrificing accuracy or sensitivity. One operator is able to record the successive time intervals for the inverse-rate curve, with their aid, and no time is subsequently required for the reading and counting of the chronograph record; the intervals so recorded may be plotted directly. (Abstract from Scientific Paper No. 336)

Behavior of Graphite Eutectoid in White Cast Iron

NOTES ON THE GRAPHITIZATION OF WHITE CAST IRON UPON ANNEALING, P. D. Merica and L. F. Gurevich. The annealing or graphitization ranges of temperature were determined for three different compositions used for car wheels. The temperature of initial precipitation of temper carbon for six hours of annealing was not noticeably affected by variation of sulphur content from 0.10 to 0.20 per cent, or by variation of total carbon content from 3.60 to 3.90 per cent, although the effect of greater carbon content is to narrow the temperature range within which graphitization is complete.

The temperature of beginning precipitation of temper carbon was about 830 deg. for the six-hour period of annealing, and about 725 deg. cent. for the 48-hour period. The maximum allowable temperature, therefore, for the annealing or "pitting" of car wheels is about 725 deg. cent.

After complete decomposition of all free cementite by annealing at from 1000 deg. to 1100 deg. cent. and cooling at equal rates in a laboratory electric furnace, less graphite is found in a specimen cooled from a 1100 deg. than in one of the same composition cooled from 1000 deg. cent. This indicates that graphite separates directly from solid solution upon cooling when its nuclei are already present.

The fact that only 0.20 per cent of combined carbon was found in some specimens after annealing at high temperatures, and cooling slowly in the furnace would indicate either that the graphite eutectoid lies at much lower values of carbon content than has been previously supposed; that there is at those rates of cooling a direct precipitation of graphite eutectoid, or that there is a formation of graphite from pearlite at temperatures directly below that of its formation. (Technologic Paper No. 129)

Results of Tests of Wire Rope

STRENGTH AND OTHER PROPERTIES OF WIRE ROPE, J. H. Griffith and J. G. Bragg. The paper presents the results of tests on 275 wire ropes submitted by American manufacturers to fulfill the specifications framed by the Isthmian Canal Commission in 1912. The samples were selected by Government inspectors for acceptance tests of material to be used at the Canal Zone.

The ropes ranged in diameter from ¼ to 1½ in., a few being of larger diameters up to 3¼ in. Over half the specimens were plow and crucible cast-steel hoisting rope of 6 and 8 strands, 19 wires each. The remainder were galvanized steel guy rope and iron tiller ropes of 6 strands 7 wires, and 6 strands 42 wires, respectively.

The investigation was made primarily to determine the tensile strengths of the ropes. Much of the experimentation was of a supplementary character—to determine the general laws of construction of the rope as the basis of the interpretation of their physical behavior under stress. A comparative analysis was made of the chemical constituents of steel, rope fibers and lubricants of plow ropes submitted by different manufacturers.

The wires at the ends of specimens were "frayed out" to form a "broom." These were inserted into molds, into which molten zinc was poured so as to form conical sockets for connection to the testing machines. Most of the tensile tests were made on a 600,000-lb. Olsen testing machine, the ropes of large diameters being tested on the 1,200,000-lb. Emery machine. Stress-strain measurements were made on over half the specimens. Numerous tests of individual wires were conducted in tensile, bending and torsion machines. The strengths of the cables were studied in connection with their modes of construction, the strengths of their component wires, and the types of fractures which were presented.

The homologous linear dimensions of the strands, wires and fiber cores were found to vary in direct proportion to the diameters of the ropes. The diameters of the strands and fiber cores were generally ⅓ the diameter of the rope. The mean pitch or lay of the strands was 7½ diameters. The mean lay of the wires was 2¾ diameters. The mean diameter of the wires was expressed by the equation:

$$d = KD/(N + 3)$$

where d = diameter of wires
D = diameter of rope
N = number of wires in outer ring of wires of a strand

$$K = \begin{cases} 1.0 \text{ for hoisting and guy rope} \\ 0.8 \text{ for extra flexible 8 x 19 hoisting rope} \\ 0.33 \text{ for tiller rope.} \end{cases}$$

The aggregate cross-sectional areas of the wires was expressed approximately by the equation:

$$A = CD^2$$

where $C = 0.41$ for 6 x 19 plow steel hoisting rope
$= 0.38$ for 6 x 19 crucible steel hoisting rope
$= 0.38$ for 6 x 7 guy rope
$= 0.35$ for x 17 plow-steel rope
$= 0.26$ for 6 x 42 iron tiller rope.

It was found when the maximum loads determined from tensile tests were platted as functions of the diameters of the ropes that the curves bounding the lower frontiers of each zone comprising the observed values were in close agreement with similar curves platted from the minimum strength stipulated in the specifications of the Isthmian Canal Commission of 1912. These strengths were also in approximate agreement with the standard strengths recommended in 1910 by the manufacturers from the results of their tests of cables similarly classified. The minimum strengths found from the present investigation are given by the following empirical equation:

$$\text{Load} = C \times 75{,}000D^2$$

where D = diameter of wire rope in inches

$$C = \begin{cases} 0.9 \text{ to } 1.1 \text{ (mean, about 1.0) for 6 x 19 plow-steel cables} \\ 0.8 \text{ to } 0.95 \text{ (mean, about 0.9) for 8 x 10 plow-steel and 6 x 19 crucible cast-steel cables} \\ 0.3 \text{ to } 0.4 \text{ (mean, about 0.35) for iron tiller and steel guy rope.} \end{cases}$$

The modulus of the rope calculated from stress-strain measurement was found to vary from 3,000,000 to 9,000,000 lb. per sq. in., depending upon the diameter and class of cable.

Plow-steel ropes were selected for comparative analyses of the constituent materials. In the chemical analyses the carbon content ranged from 64 to 96 per cent, with a mean of about 75 per cent. The manganese ranged from 25 to 68 per cent, the silicon from 11 to 24 per cent. The percentage of phosphorus and sulphur was relatively low. In certain cases the steel of the filler wires was softer than the main wires.

The fibers used in making the core of the rope were estimated as manila, jute, istle, mauritius, manila fiber alone being employed by certain manufacturers. The preservative and lubricants on the cores were composed of wood and vegetable tars, petroleum products, and fish oil, the practice varying somewhat.

There was a reasonable uniformity in the strengths and elongations of the wires from a particular cable, but a larger variation in the strengths of the wires from cables of different manufacturers. This was probably due to the fact that different grades of plow steel were used by the several manufacturers in meeting the provisions of the specifications.

The cables developed from 72 to 90 per cent of the aggregate strengths of the wires. The upper limit of the ratio of the strength of a rope to the strengths of its wires was found from theoretical considerations to be 89.2 per cent for 6 x 19 plow-steel cables. The differences between the results of the theoretical analysis and the practical tests were largely attributed to different strengths and degrees of ductility of the wires, this causing an unequal distribution of the load among the strands with overstressing of certain strands near the point of failure. (Technologic Paper No. 121)

THE EFFECT OF RATE OF TEMPERATURE CHANGE ON THE TRANSFORMATIONS IN AN ALLOY STEEL, H. Scott. Cooling curves taken on an air-hardening steel of the high-speed tool-steel type show two critical points on cooling from 920 deg. cent., one occurring at about 750 deg. cent., accompanied by the precipitation of the hardening constituent, the carbide, and the other on fast cooling at about 400 deg. cent., under which condition the carbide remains in solution as martensite. On cooling at intermediate rates both transformations are observed, and the constituents, troostite and martensite, are detected by the microscope. A transformation is observed on the heating curves taken following a fast cooling, which is manifested by an evolution of heat ending at about 645 deg cent., and which represents the precipitation of the carbide held in solution as a result of the previous rapid cooling. The re-solution of the carbide under those conditions occurs at a temperature some 10 to 15 deg. cent. higher than after a slow cooling.

The conclusions drawn support the twenty-year-old theory of Le Chatelier that martensite is a solid solution of carbide in alpha iron. (Abstract from Scientific Paper No. 335)

ENGINEERING MATERIALS

EXAMINATION OF MATERIALS BY X-RAYS. Report of the general discussion at a joint meeting of the Faraday Society and the Roentgen Society, held April 29, 1919, Sir Robt. Hadfield, Mem. Am. Soc. M. E., presiding.

Prof. W. H. Bragg, of the University College, London, showed the extraordinary sensitiveness of the X-ray method of investigation. The transparency of a material to X-rays decreases as the atomic weight of the material increases. Heat has no influence, and a red-hot casting gives the same radiograph as a cold casting. Photographs of good and faulty castings and welds were exhibited, the tool marks showing quite distinctly. Considering how minute the difference in thickness due to tool marks is, this indicates the remarkable sensitiveness of the method. An attempt was made to explain this high sensitiveness. The question as to whether hard or soft X-rays should be used was next taken up by Professor Bragg. For penetrating through the material the rays should be hard, but in that case they also penetrated through the plate, which is not an advantage. That action was due to the liberation of electrons which darted to and fro among the surrounding atoms until their energy was spent. In the emulsion, electrons were set in motion mainly through absorption of X-rays by the silver and bromine, and that action might be reinforced by putting heavy atoms into the emulsion. Some experimenters placed a thin lead sheet on the film, so that the electrons generated in the lead struck back into the photographic plate. The variation in the absorption of rays of different wave lengths, studied by the Due de Broglie and others, suggested a further consideration. As wave length increased the absorption by a given substance also increased; but at a certain value, critical for each substance, the absorption suddenly dropped, to rise again steadily afterwards. There was, therefore, a "step down" in the photograph—it should not be called a band—marking the critical wave length for silver. A similar "step up" on the side of short wave length would be obtained by interposing an absorbing screen, say of antimony or some other metal, in the path of the rays. That "antimony line" was so sharp that it might serve for a new method of spectroscopic examination of the constituents of a material. We might also put some special material in the emulsion and choose X-rays intermediate between the actual value of this material and of the casting under test; but this did not appear practicable.

A paper by E. Schneider on "The Industrial X-Ray Examination of Methods at the Laboratories of Messrs. Schneider & Co., Le Creusot, was read.

Two German papers have been translated and presented in abstract; one of these papers by Doctor Respondek of Hallensee, near Berlin, outlined the principles covering the penetration of metals by X-rays, and the other by F. Janus of Munich and M. Rettchen of Cologne explained the investigation of metals by means of X-rays. (*Engineering*, vol. 107, no. 2783, May 2, 1919, pp. 576-578, 1 fig., *e*)

HYDRAULIC ENGINEERING

Experimental Data on Conditions Covering Surge Pressures in Pipe Lines

SURGE PRESSURES IN PIPE LINES, Ralph Bennett. Description and data of tests made to determine the actual effect of varying the conditions on two pipes equipped with air chambers and of changing choke-gate areas. In these tests a simple apparatus was

used giving a time-pressure record of the variations which took place at shutdown in these pumping lines, the lines on the test being 18 in. and 24 in. in diameter. Further, the 18-in. line was equipped with the plain air chamber, while the 24-in. pipe was without any protection against shock.

In these tests the pencil mechanism of a steam indicator was so arranged that it made a record on a strip moved by the clockwork train taken from a high-speed recording voltmeter. The apparatus gave records sufficiently accurate for the purpose, though subject to the usual disadvantages of the steam indicator when used on water.

The indicator was connected at the base of the air chamber (Fig. 6), the reading being the pressure of the line. In one case the instrument was transferred to a point above the diaphragm to obtain a record of tank-pressure changes, and the curve was superimposed on the pipe-line curve secured from an otherwise similar test (Fig. 8*F*). Thus curve shows graphically the time and intensity relations of the internal and external pressures when an almost perfect damping is attained in a single swing.

The vertical scales shown on the curves are those corresponding

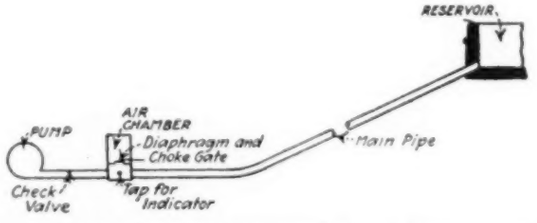


FIG. 6 TEST APPARATUS FOR RECORDING SURGE PRESSURES IN PIPE LINES

to the spring used. Owing to indicator friction and secondary pressure disturbances the curve peak values may vary considerable from actual values.

The horizontal scale of time must be averaged, as minor irregularities of drum movement affect the record. The time given for the waves is that of the half-wave after completion of shutdown when the column is vibrating as a free or loaded pendulum.

The 18-in. line was of riveted steel, average thickness 0.087 in., total length 3187 ft. The maximum head was 240 ft. (104 lb. per sq. in.) and the grade uniform without sharp bends or obstructions. The air chamber at the pump is 36 in. in diameter and 10.5 ft. long above the line, which passes directly through it. The pump delivering by test 954 gal. per min. gave a line velocity of 0.2 ft. per sec.

Shutdown tests were made on this line using varying quantities of air in the chamber. The results of some of these tests are given in Fig. 7 and in the original article in a table.

Further tests were made on the 24-in. pipe of a total length of 6791 ft. and with a maximum head of 160 ft. (70 lb. per sq. in. including friction) and uniform grade without sharp bends or obstructions.

The air chamber is 48 in. in diameter with 15 ft. effective height and a line velocity of 1.33 ft. per sec. is used.

The choke valve on the pump (two-stage centrifugal) was an

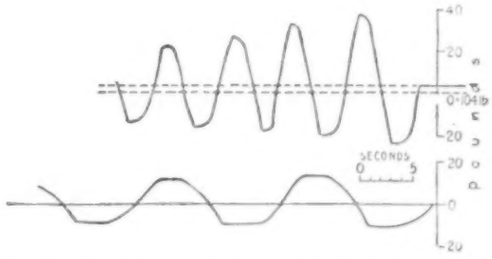


FIG. 7 GRAPHS FROM TESTS ON 18-IN. PIPE LINE

egg-shaped plunger controlled as to speed of closing by a bypassed plunger. The free actual was as rapid as that of a swing check.

On this line tests were made for numerous volumes of air and for different choke openings.

Fig. 8*A* shows the card obtained with 67 cu. ft. of air and a 25.87-sq. in. choke. Under this condition, the fall of pressure at shutdown is very severe, and the oscillations die down very quickly. The condition desired is one in which the greatest possible absorption of energy occurs across the choke from the instant of shutdown. The best condition occurs when the first half-wave (in this case negative) is the one in which the greatest loss occurs.

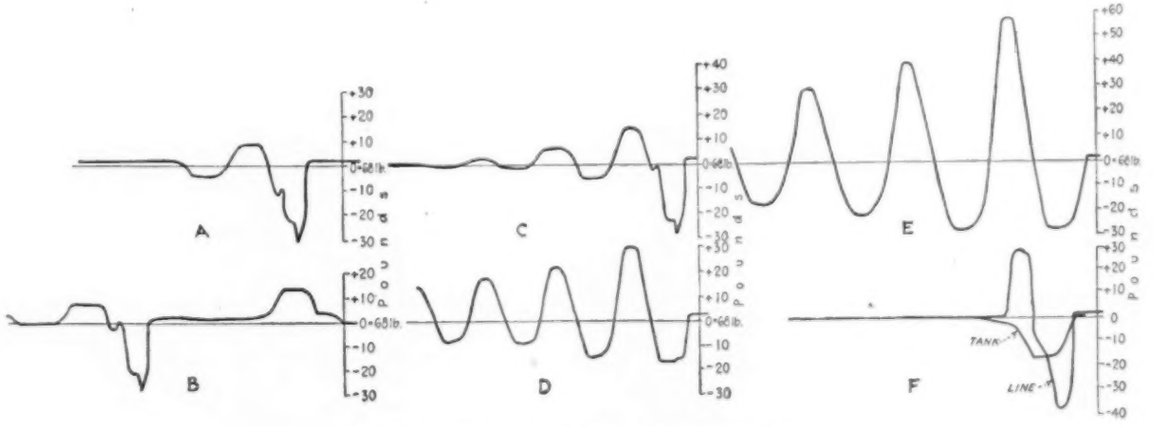


FIG. 8 GRAPHS FROM TESTS OF 24-IN. PIPE LINE
(Above—air, 14 cu. ft.; below—air, 118 cu. ft.)
(*A*—air, 67 cu. ft.; choke, 25.9 sq. in.; *B*—air, 67 cu. ft.; choke, 32.0 sq. in.; *C*—air, 35 cu. ft.; choke, 25.8 sq. in.; *D*—air, 35 cu. ft.; choke, 45.0 sq. in.; *E*—air, 90 cu. ft.; choke, 68.0 sq. in.; *F*—superimposed tank and line pressures.)

The ability of the line to stand reduction in pressure will frequently limit the possible control.

Note on this curve the great distortion of the fundamental wave of the shock from the check valve. This superimposed pressure may at times become very serious, but, as stated above, any attempt to control it by slow valve action is a move in the wrong direction. Better results would be obtained by a loaded valve.

Fig. 8*B* was obtained with the same air content, 67 cu. ft., and a 32-sq. in. choke. The check-valve disturbance is much as before. The indicator was put on the line before the pump was started, and the entire cycle from standstill to standstill is shown. Note that the shock due to the rapid start of the pump is more severe than is that due to the shutdown surge.

The quantity of air and the closeness of the choke can be varied within limits with about the above results, but any considerable decrease in the amount of air reduces the ability of the tank to absorb energy and increases both the pressure peaks and the

number of undulations required for full absorption of the energy in the water. Curves in Figs. 8*C* and 8*D* show these effects very clearly. Fig. 8*C* shows good control with 35 cu. ft. of air and a 25.8-sq. in. choke, while Fig. 8*D*, with the same volume, produces an excessive shock.

If the tank contains ample air but is too freely connected to the line, a condition results similar to that shown in Fig. 8*E*, which was taken when the air supply, 90 cu. ft., was more than ample for full pressure control but with no excessive opening, 68 sq. in. (*Engineering News Record*, vol. 82, no. 2, May 29, 1919, pp. 1048-1050, 9 figs., *eA*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics)

Oscillograph Tests of Various Types of Spark Plugs

SPARK-PLUG EFFICIENCY, Maj. A. M. Low. Data of tests on the intensity and duration of ignition sparks and conditions affecting them.

The writer states that pointed electrodes are ape to produce brushing, which may sometimes be so great as to prevent the engine being started.

There is a simple experiment of passing a spark through water by insulating the electrodes so thoroughly by means of glass that the spark has no other option.

In the case of the plain 2-point type of plug the current jumps

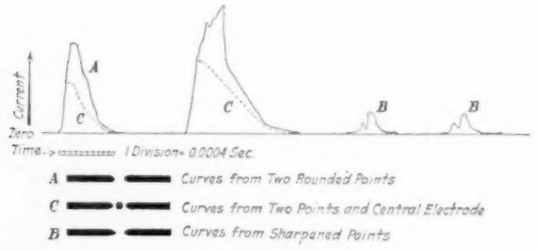


FIG. 9 OSCILLOGRAPH CURVES FROM SPARK PLUGS OF VARIOUS TYPES

the gap, but a very large proportion crosses as brush discharge and a great deal of efficiency is wasted. With the object of showing this, the author has taken a large number of photographs of the current passing, showing also the duration of the spark or spark and arc. These photographs have been reproduced in the form of diagrams, which are all drawn to scale in Fig. 9. At *A* the spark current is shown between two plain points, while in *B*, in which the plug points are sharpened, the duration and relative value of the current is much less. *C* shows the action of the plugs having a central plain electrode and two wings. The duration of the spark is the same as in *A*, but the current is slightly reduced, proving that two plain gaps in parallel are liable to waste current, as brushing occurs if the energy cannot get across the gaps with sufficient rapidity.

Fig. 10 is intended to show the fallacy of the plan if it is possible to obtain a ring of sparks. The author believes that under compression the current merely takes the path of least resistance, giving one spark at a time but at different places around the gap.

At *B* the current between the electrodes of the plate and point type of plug is shown to be high and of good duration. Fig. 11 shows the effect of two plates or two cups and points, while another figure represents the effect of three wings and one central electrode.

The plate type of plug will often give very good results if the body be not used to form one of the plates, as its large area leads to condensation and difficulty in starting, though for high-speed work it is good. In Fig. 10, *A*, the dotted line represents the current between a point and cup. If the cups are duplicated as in Fig. 11, *A*, the duration is slightly diminished and the current increased, proving that even a single cup and point waste current.

These curves have been obtained by means of a plug or gap connected in series with a Duddell oscillograph.

With almost any plug, the smaller the gap the higher is the amplitude of the current. The duration is also longer so that there is not much to be gained in having the points wide apart, though for high speed it is sometimes of advantage. While this suggests that a variable gap might be used, the author has made a good many tests with a variable-gap plug but the results obtained did not justify the increased complication.

Tests with the manograph on the engine and an oscillograph in circuit with the plug, indicated that more than two sparks per cylinder does not improve efficiency and that the temperature of the sparks which makes the first period of ignition rapid and avoids cooling of the heated particles is of much more importance than the distance between two sparks within the cylinder.

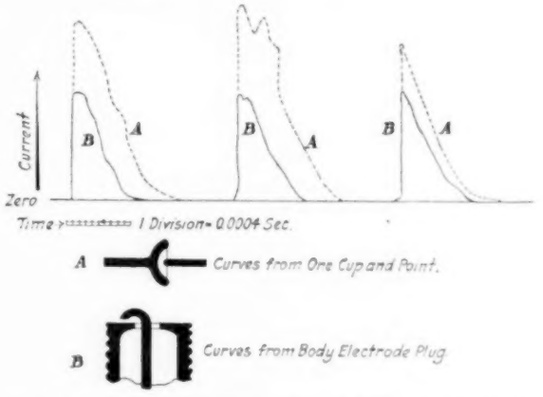


FIG. 10 OSCILLOGRAPH CURVES FROM SPARK PLUGS OF VARIOUS TYPES

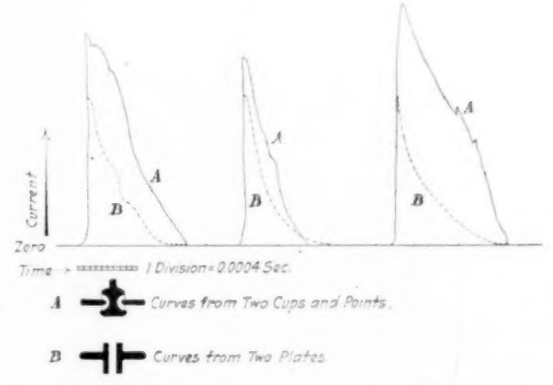


FIG. 11 OSCILLOGRAPH CURVES FROM SPARK PLUGS OF VARIOUS TYPES

It is only the very first production of the spark that is affected by the shape of electrodes, so that it is the first half of the spark that is of such importance. Different kinds of plugs may meet different requirements. The direction in which the current passes is extremely important and it was this that first led to the introduction of the cup system. (*The Autocar*, vol. 42, no. 1228, May 3, 1919, pp. 655-658, 6 figs., *e*)

STARTERS FOR LARGE MOTORS. Description of various starters, chiefly with reference to electric motors such as powder-cartridge type, auxiliary gas starters (like acetylene), compressed air, and electric starters.

An interesting type described is the Herzmark starter. Two cylinders of the engine are filled with carbureted air compressed to 5 kg. per sq. cm. (= 71 lb. per sq. in.). One of the cylinders is at the ignition point and the other in compression stroke, both being in equilibrium. Then by means of a very simple apparatus, ignition of the mixture in one of the cylinders is produced directly

by a magneto spark. The apparatus consists of a triple-action pump, taking from the carburetor a very rich mixture. A small distributor located behind this pump and carrying as many electric coils as there are cylinders indicates which of the cylinders is at the ignition point. An electric connection from a dry-cell circuit with the camshaft acts on the coil which corresponds to it. After a certain number of pump strokes which vary in accordance with the cylinder volume of the engine, all that is necessary is to bring the little movable handle of the distributor over the active coil and apply the catch in order to deliver automatically the mixture into the proper cylinders.

The pump is located right at the pilot's hand and is connected to the engine by two small tubes so that the engine may without any inconvenience be placed at a distance of 25 to 30 ft. from the pump.

It is stated that the starter is of simple construction, quite light (4 kg. or 8.8 lb.) and that it occupies little space (40 cm. by 12 cm. = 15.7 in. by 4.7 in.).

The original article has an illustration of this starter, too indistinct, however, to permit reproduction. (D. J., in *L'Aerophile*, vol. 27, no. 34, Feb. 1-15, 1919, pp. 45-46, 1 fig., *d*)

LUBRICATION (See also Air Machinery)

Practical Data on the Lubrication and Cleaning of Air Compressors

PROPER LUBRICATION OF AIR COMPRESSORS, H. V. Conrad. To be satisfactory, lubrication of air-compressor cylinders should first reduce friction to a minimum, and, second, eliminate as far as possible carbonization of the oil.

The formation of excessive carbon deposits is apt to be due to use of improper oil such as oil of to great a viscosity; use of too great quantities of oil and failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dust (coal dust being especially undesirable). Besides the usual objections to carbonization such as sticking of air valves and choking of air passages in the case of air-compressor cylinders, there is a further menace of fire. Carbon particles may become incandescent and cause a fire by coming in contact with oil vapor given off by lubricating oil.

The paper discusses the qualities of various lubricating oils and a basis for making a selection of the proper oil. In particular, data are given on the properties of paraffine-base and asphaltic-base lubricating oils.

As regards the question of quantity of lubricating oil, it is said that while it depends to a certain extent on the viscosity of the oil, heat of compression and size of cylinder in general, it may be stated that after the cylinders have acquired smooth and polished surfaces the quantity should be reduced to the lowest limit. Table 1 is given as a basis for determining the quantity of oil used. The results in the last column are based upon the assumption that under average conditions of temperature and usual range of oil viscosities a pint of oil will contain an average of about 16,000 drops.

For cleaning the air-compressor system and removing carbon it is recommended to use only soap suds. A good cleansing solution is made of 1 part soft soap to 15 parts water. These suds should take the place of oil for a few hours and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator at a rate about ten times as rapidly as that of the oil.

For cleaning the air receiver and piping a method is suggested, shown in Fig. 12, where a receptacle made of 6-in. pipe is set on top of the discharge pipe.

A cleansing liquid recommended consists of 1 lb. of Red Seal lye to 18 lb. of water. This mixture is passed into the discharge line at the rate of 60 or 70 drops per min. while the compressor is running.

To use the arrangement shown close cocks *A* and *G*, open valve *C* and fill compound through funnel *D;* when chamber *E* is filled, closed valve *C*, open cocks *G* and *A* and regulate feed by valve *B*.

TABLE 1 QUANTITY OF AIR-CYLINDER LUBRICANT REQUIRED PER 10-HOUR DAY

Diameter of Cylinder, in.	Size of cylinder, in.	Displacement per minute, cu. ft.	Piston speed, ft. per min.	Sq. ft. of cylinder wall swept by piston	Drops oil per min.	Drops oil per 10 hr.	Sq. ft. oiled per drop	Pints of oil required per 10 hr.
8	8 × 8	120	344	718	1	600	718	0.0375
12	12 × 12	320	408	1230	2	1200	613	0.0750
18	18 × 18	880	496	2340	4	2400	585	0.1500
24	24 × 24	1730	550	3450	6	3600	575	0.2250
30	30 × 30	2940	600	4700	8	4800	590	0.3000
36	36 × 36	4550	644	6070	10	6000	607	0.3750
42	42 × 42	6700	696	7600	12	7200	633	0.4500

Figures of last column are based upon estimated 16,000 drops per pint of oil at 75 deg. fahr.

The oil should be fed at the rate of about 70 drops per min. (*The Blast Furnace and Steel Plant*, vol. 7, no. 5, May 1919, pp. 224-226 and 242, 1 fig., *gp*)

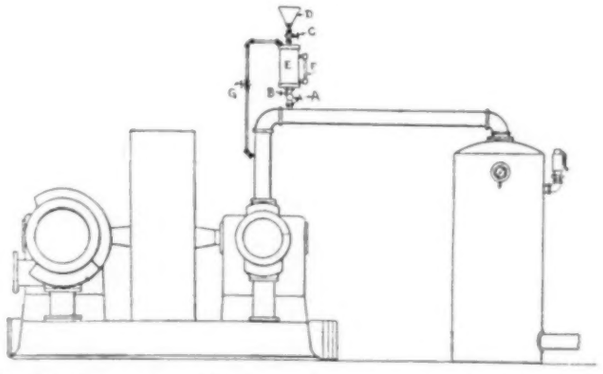


FIG. 12 DEVICE FOR REMOVING CARBON IN AIR-DISCHARGE LINE AND RECEIVER OF AIR COMPRESSORS

A—Pressure cock; *B*—Regulating valve; *C*—Filling Valve; *D*—Funnel; *E*—Compound chamber; *F*—Gage glass; *G*—Pressure cock.

MACHINE SHOP

Theory of Tolerances and Comparison of Symmetrical and Asymmetrical Systems

TOLERANCES IN MECHANICAL CONSTRUCTION, A. C. An article based on a publication by Doctor D'Ailly of the C. E. Johansson Gage Company.

There are two kinds of tolerances, the theoretical and the practical. The theoretical tolerance comes from the imperfection of our instruments and our senses and the more the appliances and processes for checking are improved the more the theoretical tolerance may be reduced, but it will probably never be entirely eliminated.

In manufacturing it is usually entirely unecessary to strive to attain the limits of theoretical tolerance and a lesser precision known as practical tolerance is as a rule sufficient.

Graphically, the regions of tolerance may be shown in the following manner: Assume that a is the nominal value of the required dimension—for example, the theoretical diameter of a lot of shafts; $x_1, x_2, \ldots x_n$ are the real values of the diameters of these shafts; and that $y_1, y_2, \ldots y_n$ are the numbers of shafts which actually have the diameters $x_1, x_2 \ldots x_n$.

From the calculus of probabilities it is found that the relation between x and y is expressed by the function

$$y = ke^{-h^2(x-a)^2}$$

where e is the base of the Napierian system of logarithms and k

and h are coefficients depending on the perfection of the methods of machining employed in each instance. No matter, however, what the values may be, the representative curve for this equation tends to assume the form shown in Fig. 13; that is, the curve is always symmetrical with respect to the ordinate OY, for which $x = a$.

It is easy to show on this curve the region of theoretical tolerance. Let $\pm \varepsilon$ be the magnitude of theoretical tolerance expressed in the same units as a; the ordinates corresponding to the abscissæ $a + \varepsilon$ and $a - \varepsilon$ indicate the sectioned area in Fig. 13 symmetrical with respect to the ordinate of $x = a$, which represents the region of tolerance, so that all the shafts of which the diameter lies between $a + \varepsilon$ and $a - \varepsilon$ correspond to points of the curve comprised between A and B. The same graphical representation applies to practical tolerances. As a matter of fact, shafts accepted by the inspection are, by the very definition of practical tolerance, those of which the diameter does not differ from a by more than a certain predetermined tolerance.

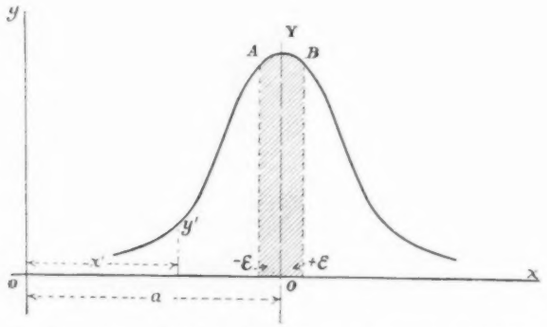


FIG. 13 GRAPHICAL REPRESENTATION OF REGIONS OF TOLERANCE, SYMMETRICAL SYSTEM

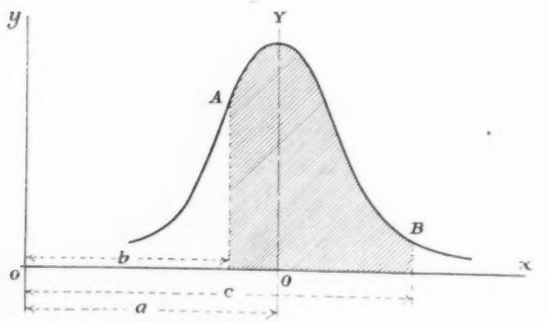


FIG. 14 GRAPHICAL REPRESENTATION OF REGIONS OF TOLERANCE, ASYMMETRICAL SYSTEM

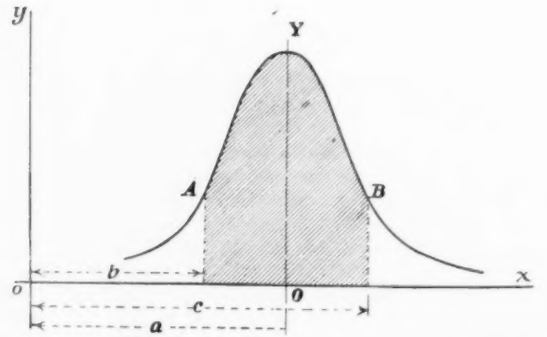


FIG. 15 RELATION BETWEEN THEORETICAL AND PRACTICAL TOLERANCES

Thus, let b be the minimum acceptable diameter and c the maximum (Fig. 14). The region of practical tolerance AB is here also represented by a cross-sectioned area comprised between $x = b$ and $x = c$. If a is the average between b and c the region of practical tolerance will be like that of theoretical tolerance, symmetrical with respect to the ordinate $x = a$. However, the designer may or may not adopt such a symmetry, and in what follows will be presented some of the advantages of symmetrical tolerances.

The whole purpose of tolerances is to permit a correct adjustment and good operation of assemblies constituting a machine. These assemblies may be such as to permit no play between the parts, or such as to require a certain greater or lesser amount of play. For example, in Fig. 16 is shown a rotating shaft and its journal, an assembly in which a certain predetermined amount of play is necessary.

Let us say that t_1 and t_2 are respectively the tolerances for the diameter D_1 of the shaft and the bore D_2 of the bearing. The shaft may then have a diameter which varies between D_1 and d_1 and the bearing may have bores varying from D_2 to d_2. In the first case the minimum play will be j; in the second case the maximum play will be j' and it is obvious that $j' - j = t_1 + t_2$. In other words,

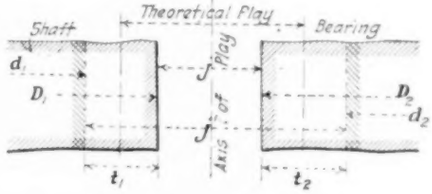


FIG. 16 REGION OF TOLERANCE AND PLAY BETWEEN THE SHAFT AND ITS BEARING

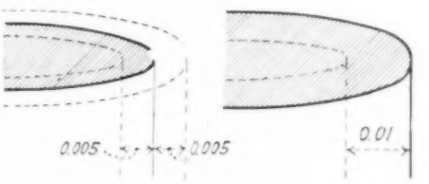


FIG. 17 SYMMETRICAL AND ASYMMETRICAL TOLERANCES

the total tolerance T or the play permitted is the same as the tolerances of the pieces which have to be assembled.

Symmetrical and Asymmetrical Tolerances. After the tolerance for a given piece has been selected it may be used either on the symmetrical or on the asymmetrical system. For example, let the nominal diameter of a shaft be 100 mm. with a tolerance of 0.01 mm. On the symmetrical system this tolerance will apply to the range from 99.995 mm. to 100.005 mm. In the second case there may be a difference in the permitted dimensions above and below 100 mm.; for example, 99.997 mm. to 100.007 mm. There may even be given a range from 99.990 mm. to 100.000 mm., in which case the entire tolerance will lie on one side of the given dimension.

The diagrams of Fig. 17 show at once that the symmetrical system, under equal conditions of manufacture, is more exact than the asymmetrical, because the permissible deviation of diameter is at most one-half of the tolerance, while in the asymmetrical system this deviation may be equal to the entire tolerance.

On the other hand, if, in an assembly such as, for example, a shaft and a bearing, it is desired to reduce the relative tolerance between the shaft and the bearing without varying the theoretical play, then (as apparent from Figs. 18 and 19) in the case of the symmetrical system (Fig. 18), the nominal diameter of the pieces is not altered by the change, and hence the nominal magnitudes on the drawings do not have to be changed when production with a

large tolerance (Case I) is changed to production with a smaller tolerance (Case II).

On the contrary, in the asymmetrical system the passage from Case I to Case II involves a change in the nominal diameter D equal to half the difference between tolerance t_1 and t_2, which can be seen by examining the left side of Fig. 19. In a shop this would involve remaking the drawings and indicating the nominal dimensions in complicated decimal fractions instead of in round figures.

Another case may be cited where the advantage of the symmetrical system is very appreciable. This is the case where it is desired in a lot of pieces, such as shafts, passed with the tolerance t, to carry out a new inspection and pass only the pieces satisfying a much smaller tolerance, for example, $t/2$. This may actually occur in course of production when the shop has a certain amount of completed stock on hand, and suddenly the market

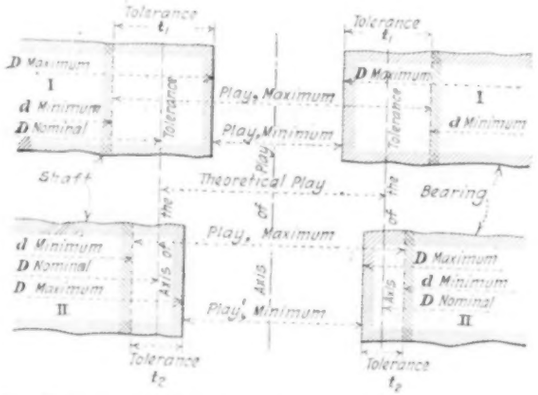


FIG. 18 VARIATION OF TOLERANCE WITH THE SYMMETRICAL SYSTEM

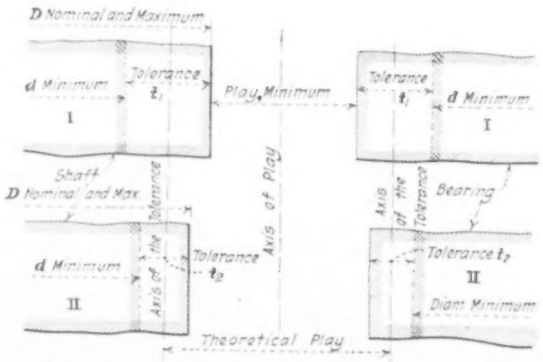


FIG. 19 VARIATION OF TOLERANCES WITH THE ASYMMETRICAL SYSTEM

begins to demand a smaller tolerance than the one which was current previously.

With this in mind the symmetrical and asymmetrical systems are compared, the tolerance being first t and then $t/2$ (Figs. 20 and 21).

The first to be considered (Fig. 21) is the scheme with the shaft adjusted on the basis of symmetrical tolerance. The different diameters which have been considered in this case are:

D, or nominal diameter corresponding to the axis of symmetry OY and the region of tolerances;

D_1, or maximum diameter, and d_1, or minimum diameter corresponding to a tolerance t;

D'_1 and d'_1, maximum and minimum diameters corresponding to a tolerance of $t/2$. The whole figure is symmetrical with respect to the axis OY.

The writer next plots the curve

$$y = ke^{-h^2(x-D)^2}$$

(the constant a of the general equation given above represents in this instance the nominal diameter D) of which the axis of symmetry is likewise OY since it corresponds to the nominal diameter D; the regions of tolerance corresponding respectively to t and $t/2$ and defined by the ordinates Aa and Bb for tolerance t and by Cc and Dd for the tolerance $t/2$. These two regions have in common the zone shaded by intersecting lines with the area $2S$.

The same operation (Fig. 21) may be carried out for the case of a shaft machined on the basis of asymmetrical tolerance. Here the tolerances t and $t/2$ are considerably below the nominal

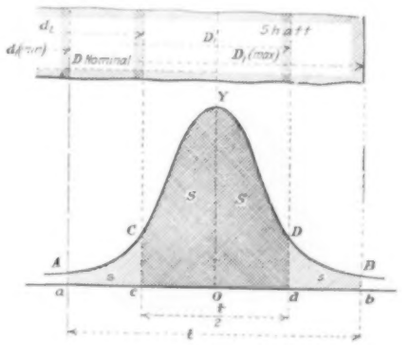


FIG. 20 GRAPHICAL REPRESENTATION OF THE REGIONS OF TOLERANCE WITH THE SYMMETRICAL SYSTEM

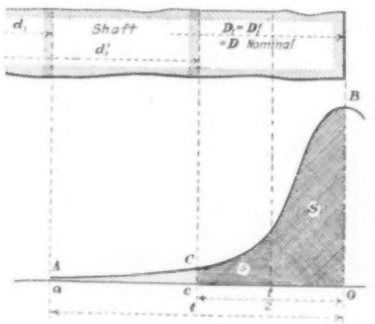


FIG. 21 GRAPHICAL REPRESENTATION OF THE REGIONS OF TOLERANCE WITH THE ASYMMETRICAL SYSTEM

diameter D, which may be easy to confuse with the maximum diameters D_1 and D'_1. The axis of symmetry of the curve

$$y = ke^{-h^2(x-D)^2}$$

is OY and the regions of tolerance are respectively defined by the ordinates Aa and BO for t and Cc and BO for $t/2$.

Here again the common part of the two regions of tolerance is represented by the shaded zone, but the area of this zone is equal to $s + S$ instead of $2S$.

If a regaging of the stock of shafts having the tolerance t be carried out and only those which have the tolerance $t/2$ be passed, the number of pieces to be kept will be represented by the cross-sectioned zone of area $2S$, where the symmetrical system of tolerances is in use, and by a zone of area $S + s$ in the case of the asymmetrical system, the difference in favor of the symmetrical system being represented by the difference between these two areas or by $S - s$. (Remarques sur le Système des Tolérances dans les Constructions Mécanique, A. C. *Le Génie Civil*, vol. 74, no. 11, May 3, 1919, pp. 353-355, 10 figs., *tp*)

MACHINE TOOLS, METAL-WORKING

CONTINUOUS MILLER. Description of a continuous milling tool designed by the Oesterlein Machine Co., Cincinnati, Ohio, which presents some novel features.

The body of the machine in general design resembles that of a punch press and is cast in one piece. It is claimed that the possibility of springing, due to working the machine to its maximum capacity, is avoided by the fact that the working surface of the platen and the cutter spindle are contained within the limits of the base casting.

The cutter can be held in a fixed position and the platen rotated continuously by means of an automatic feed, or the cutter may be reciprocated radially in combination with an intermittent motion of the table which is controlled by an indexing mechanism.

The spindle drive, Fig. 22, is taken from the driving pulley by means of miter gears to an intermediate shaft which connects with the first change-gear shaft in the speed box by means of a second pair of miter gears. The first and second change-gear shafts are connected by a single pair of change gears. The

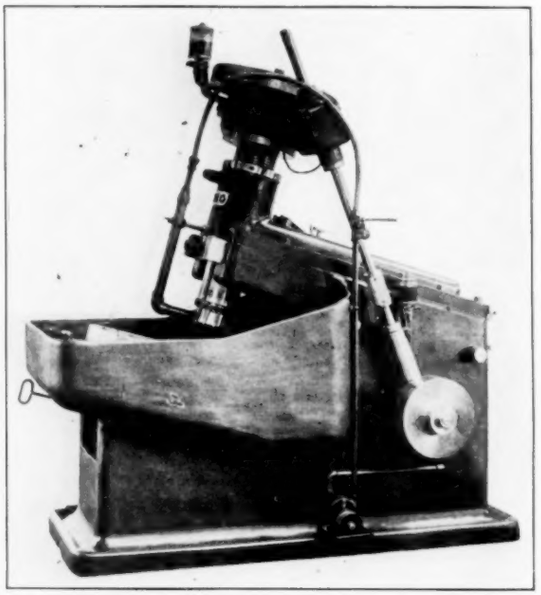


FIG. 22 SPINDLE-DRIVE MECHANISM IN THE OESTERLEIN CONTINUOUS MILLER

spindle speed is varied by means of pick-off gears on the two shafts.

The spindle sleeve is provided with a vertical adjustment by means of a graduated collar which engages a coarse thread on the spindle sleeve. The spindle sleeve is clamped firmly in the split barrel of the ram after it is adjusted. The ram is fed radially over the surface of the platen by means of a cam which feeds the ram forward slowly during the cutting operation and permits it to drop back rapidly at the end of the stroke.

The relative travel of the ram is adjustable through the medium of a slide mounted under it. The slide is operated from the side of the ram by means of a bell-crank lever and is clamped with a knurled knob. The cam is driven by a worm and worm wheel in the feed box. A 4-gear feed-change mechanism regulates the platen feed when the continuous motion is in use. It also regulates the rate of speed of the cam when the indexing mechanism is employed. Thus the cutting feeds are established by the ratio of these change gears. The ratios are obtained by pick-off gears.

The rotary platen is set at a 15-deg. angle and is driven by a hardened worm and worm wheel. The worm is provided with ball thrust bearings and the box that carries the worm is gibbed to provide a means for compensating for the wear between the worm and worm wheel. (*Iron Trade Review*, vol. 64, no. 21, May 22, 1919, pp. 1359-1360, 3 figs. *d*)

MECHANICS

Application of Slope Deflection Method to Analysis of Statically Indeterminate Structures

ANALYSIS OF STATICALLY INDETERMINATE STRUCTURES BY THE SLOPE DEFLECTION METHOD, W. M. Wilson, F. E. Richart and Camillo Weiss. Frames composed of rectangular elements must in general be designed with stiff connections between the members at the joints, in order that loads may be carried. These connections must be capable of transferring not only direct axial tensile and compressive forces, but also bending moments. It follows that frames made up of rectangular elements are usually statically indeterminate; that is, the stresses in them can be found only by taking into account the relative stiffness and deformations of the various members. The common use of rectangular frames in engineering structures makes it highly desirable that the most convenient methods of analyzing their stresses should be developed. The stresses in a number of such rectangular frames have been analyzed by the writers and in their investigation they have made use of the so-called moment-area method given practically simultaneously in 1868 by O. Mohr in Germany and by C. E. Greene in lectures at the University of Michigan in this country.

The fundamental equations used in these investigations are expressed as follows:

1 When a member is subjected to flexure, the difference in the slope of the elastic curve between any two points is equal in magnitude to the area of the M/EI diagram for the portion of the member between the two points.

2 When a member is subjected to flexure, the distance of any point Q on the elastic curve, measured normal to initial position of member, from a tangent drawn to the elastic curve at any other point P is equal in magnitude to the first or statical moment of the area of the M/EI diagram between the two points, about the point Q.

The M/EI diagram is a graph in which the ordinate at any point is obtained by dividing the resisting moment, M, by the product of modulus of elasticity of material, E, and the moment of inertia of the section, I, at that point. If E and I are constant, the diagram will be similar in shape to the moment diagram for the member.

The fundamental equations are derived for moments at ends of members in flexure under various conditions of load and support, after which the writers proceed to the determination of stresses in statically indeterminate structures, to which by far the greater part of their discussion is devoted.

In this, two general methods of using the equations have been illustrated. In one case, after the equations have been written for each member of a frame by equating the sum of the moments at each joint to zero and employing one equation of statics, a number of equations are obtained which contain values of θ (angle between radii) and R $(= d/l)$ as the only unknowns. From these equations can be found the values of θ and R, which, when substituted in the original slope deflection equations, give values of the various moments. This method applies especially well to a frame in which a large number of members meet at each joint. Such a problem is generally best solved in numerical terms.

The procedure in the other case is more direct. The slope deflection equations for each member may be combined to eliminate values of θ and R, leaving equations involving the unknown moments, the properties of members and the given loading of the frame. These equations may be solved directly for the moments.

The following are some of the advantages of the slope deflection equations pointed out by the authors:

The general form of the fundamental equation is easily memorized, and the equations may be written for all members of a structure with little effort. The value of C or H for loaded members may be calculated by reference to two tables given by the writers. It is frequently possible to simplify the equations through noting where values of θ and R must be equal to zero from the conditions of the problem.

No integrations need be performed except possibly to find values of C and H, and there is little danger of the omission of

the effect of a single indeterminate quantity, as there is in methods involving the work of internal forces or moments.

The physical conception of a problem is easier than in the case where differentiation or integration is performed. When the slopes and deflections are determined, it is easy to visualize the approximate shape of the elastic curve of a member, whereas an expression involving the work of an indeterminate force or moment may have little physical meaning. Neither does the method of cutting a member and equating expressions for the linear and angular movement of the adjoining ends give so clear an idea of the actual deformation. To one unfamiliar with such a method the determination of the sign of the movement of the ends of the member cut is also more or less difficult.

Although the fact has not been brought out by the writers, these equations may be applied to many structures not composed of rectangular units. The determination of secondary stresses in bridge trusses is an example of such use which has been discussed in print for some time. With trapezoidal and triangular frames care must be taken in the use of the term R for adjoining members.

While the method is readily applicable to all the problems solved in this bulletin, its advantage over other methods is seen when applied to structures which are statically indeterminate to a high degree in which a number of members meet at each joint. (*University of Illinois Bulletin*, vol. 16, no. 10, Nov. 4, 1918, [Bulletin No. 108, Engineering Experiment Station], 214 pp., 112 figs., 4*A*)

STEAM ENGINEERING

Is the Bucket Efficiency in Reaction Steam Turbines Materially Lower Than in Impulse Turbines?

BUCKET EFFICIENCY OF IMPULSE AND REACTION STEAM TURBINES, Prof. Tore G. E. Lindmark. First part of an extensive abstract of a paper in a Swedish periodical. In this paper the author claims that it is frequently stated that the bucket efficiency in a reaction steam turbine must necessarily be lower than the corresponding efficiency in an impulse steam turbine as long as the ratio between the peripheral velocity and heat drop for the reaction steam turbine does not exceed the most favorable values for the impulse steam turbine.

This means, in other words, that Σu^2, which is the sum of squares of peripheral velocities, must be greater in a reaction turbine than in an impulse turbine in order that, even apart from the influence of leakage losses, the former may attain the same degree of thermodynamic efficiency as the impulse turbine.

Professor Stodola, however, has shown that the reaction turbine with one-half degree of reaction has approximately the same ability for utilizing the relatively low peripheral velocities as an impulse turbine. The following considerations are presented by the author to combat the above expressed statement, which he considers to be incorrect.

The comparison between the efficiencies of impulse turbines and reaction turbines of various degrees of reaction is here limited by the author exclusively to the consideration of the bucket efficiencies, and by bucket efficiency is here understood the efficiency which relates only to losses in the guides and buckets, but not leakage losses, etc.

The author considers in this connection only one set of guides and buckets, and investigates the bucket efficiencies at various peripheral velocities in relation to a known heat drop. The so-called loss factor which originates in losses relating to thermodynamic efficiencies does not apply at all in this connection to the case of impulse turbines, since the investigation on this type of turbine has to do with but a single expansion. On the other hand, in the case of reaction turbine, even for a single guide and bucket set there is a certain loss factor, due to the fact that the steam expands not only in the guide, but also in the bucket. The losses in the first expansion raise the heat content of the steam, and therefore the expansion in the bucket starts from a somewhat higher heat content, and the heat drop in the bucket is somewhat increased thereby. At the same time this loss factor is so near unity that it can be neglected without creating thereby any very serious error.

If, for a start, all losses in the guides and buckets are neglected and the problem is simply considered as if the only loss were due to the absolute velocity of exit from the buckets, then the results obtained will be different from what has been indicated above. If it be assumed diagrammatically that all angles are equal to zero, then for the impulse turbine the following well-known formula will be obtained:

$$\tau_{is} = 1.0 \text{ if } u/c_o = 0.5$$

where τ_{is} = efficiency of bucket

u = peripheral velocity of bucket

c_o = velocity of steam corresponding to the heat drop.

If the heat drop be denoted by W, then

$$A \times \frac{c_o^2}{2g} = W, \text{ where } A = \frac{1}{427}$$

In the case of a reaction turbine, 100 per cent bucket efficiency will not be obtained with the above indicated value of u/c_o. If the degree of reaction is, for example, 0.5, the heat drop will be divided into two equal parts between the guide and the bucket. Hence, the velocity of efflux of steam from the bucket will be

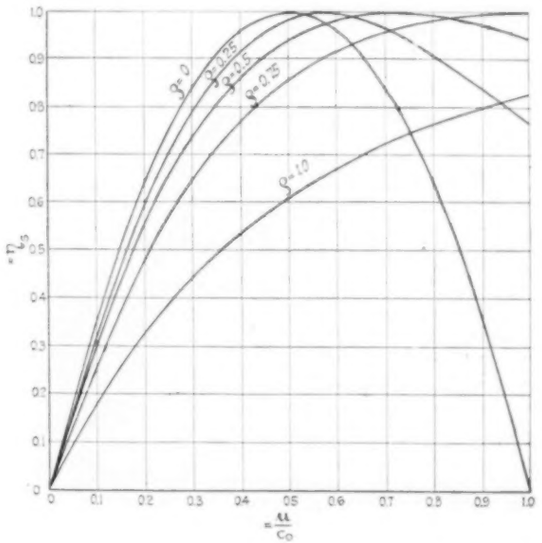


FIG. 23 VARIATION OF TURBINE BUCKET EFFICIENCY WITH THE PERIPHERAL VELOCITY FOR VARIOUS DEGREES OF REACTION

reduced to zero when the peripheral velocity is equal to the velocity of the steam, and therefore

$$\tau_{is} = 1.0, \text{ where } u/c_o = \frac{1}{\sqrt{2}} = 0.708$$

If the degree of reaction lies between zero and 0.5, then $\tau_{is} = 1.0$ for u/c_o having a magnitude between 0.5 and 0.708, and if the degree of reaction is greater than 0.5, then u/c_o must have values greater than 0.708 in order that $\tau_{is} = 1.0$.

In the case of a complete reaction, the maximum bucket efficiency of unity is obtained only when $u/c_o = \infty$.

It is of interest to see how the bucket efficiency under the above conditions varies with the peripheral velocity for various degrees of reaction.

Fig. 23 shows in the form of curves the variation of efficiencies with various u/c_o values and five different degrees of reaction, viz., 0 (pure impulse turbine), 0.25, 0.50 (the usual so-called reaction turbine), 0.75 and 1.0 (pure reaction turbine). The curves illustrate the known fact that impulse turbines under the above conditions show greater ability for utilizing peripheral velocities than reaction turbines, and the situation with respect to the latter is the worse the greater the degree of reaction, and is at its worst for the pure reaction turbine. Nevertheless, it must be recognized that even under the above assumptions the difference of the bucket

efficiency between, for example, the pure impulse turbine and the reaction turbine with the degree of reaction = 0.5 is not excessively great. For example, with $u/c_0 = 0.4$ the reaction turbine operates with an efficiency only 10 per cent lower than an impulse turbine, and with $u/c_0 = 0.5$ with an efficiency only 6 per cent lower.

At the same time care must be taken not to draw from the foregoing considerations conclusions which are not justified by actual conditions. The curves mentioned have all been derived under the assumption that all the angles are equal to zero, and that there are no losses besides the absolute velocity of exit from the buckets, which is considered as being entirely lost. With the assumption of the presence of the usual angles the curves are somewhat displaced, although in the relative relations there are no material changes between the curves. Of more importance in this connection are the changes which are introduced by taking into consideration the losses in the guides and buckets due to friction, compression, etc., and also by considering the absolute velocity of exit from the buckets as not being entirely lost.

For a start the author continues to consider the absolute velocity of exit from the buckets as entirely lost, but introduces the usual angles in the guides and buckets, and takes into consideration the losses in flow through the guides and buckets. He uses the following notation in this connection:

A = amount of steam, kg. per hr.
c_0 = theoretical velocity of efflux of steam corresponding to the total adiabatic heat drop W for guide + bucket, meters per sec.
c_1 = actual velocity of efflux of steam from guides, meters per sec.
u = peripheral velocity of buckets, meters per sec.
ω_1 = relative inlet velocity of steam to bucket, meters per sec.
ω_2 = relative outflow velocity of steam from bucket, meters per sec.
c_2 = absolute outflow velocity of steam from bucket, meters per sec.
α = angle of guide
β_1 = entrance angle of bucket
β_2 = exit angle of bucket
φ = velocity coefficient for guides
ψ = velocity coefficient for buckets
n_s = actual bucket effect of velocity forces
n_t = theoretical bucket effect of velocity forces
$\eta_{is} = N_s/N_t$ = efficiency of bucket
ρ = degree of reaction

In all the calculations that follow it is assumed that β_1 is such that there is no shock at the velocity triangle in the inlet to the bucket.

For a pure impulse turbine, that is, one where $\rho = 0$, the following equations apply:

$$A \times \frac{c_0^2}{2g} = W$$

$$\text{hence } c_0 = \sqrt{\frac{1}{A} \times 2gW} = 91.5\sqrt{W}$$

$$c_1 = \varphi\, c_0$$

$$\omega_1^2 = c_1^2 + u^2 - 2\, c_1 u \cos \alpha$$

$$\omega_2 = \psi \times \omega_1$$

$$N_t = \frac{c_0^2}{2g} \times \frac{A}{3600 \times 75}$$

$$N_s = \frac{u \times A}{3600 \times 75 \times g}(\omega_1 \cos \beta_1 + \omega_2 \cos \beta_2)$$

$$\eta_{is} = \frac{2u}{c_0^2}(\omega_1 \cos \beta_1 + \omega_2 \cos \beta_2) \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

When φ, ψ, α and β_2 are known, η_{is} can be calculated from Equation [1]. The author takes $\alpha = 18$ deg. 10 min., and $\cos \alpha = 0.95$; β_2 is taken to be equal to β_1.

For example, in turbines with guides, φ may with sufficient precision be taken to be equal to 0.95. It is more difficult to determine ψ. This coefficient appears naturally to be a function of the bending of the stream in the bucket and hence of the bucket angles β_1 and β_2. The greater $\beta_1 + \beta_2$ the less is the loss of velocity in the bucket and therefore the greater the magnitude of ψ. Professor Stodola tried to represent the function ψ/s of bucket angles in the form of a curve, but it is impossible to determine how far this curve approaches the actual conditions. It should, however, be borne in mind that the relative velocity when the stream bends in the bucket is not constant in all sections. Because of the difficulty of finding some satisfactory function determining the relations between ψ and $\beta_1 + \beta_2$ the author has assumed that ψ is not affected by the action of the angles and gives it a value 0.85, which is, roughly, a good value for multiple turbines of the

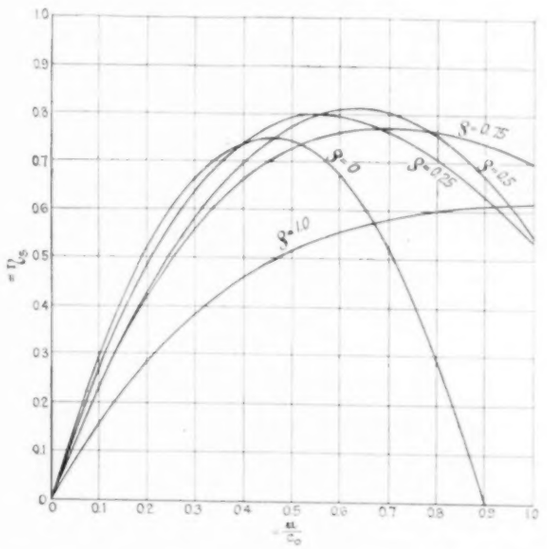


FIG. 24 VARIATION OF BUCKET EFFICIENCY OF PURE IMPULSE TURBINE WITH PERIPHERAL VELOCITY FOR VARIOUS DEGREES OF REACTION

impulse type with bucket angles of about 30 to 35 deg.

If the above numerical values be used the following equations are obtained:

$$c_2 = 0.95\, c_0 = 86.9\sqrt{W}$$

$$\omega_1^2 = c_1^2 + u^2 - 1.9 \times c_1 u$$

$$\omega_2 = 0.85\, \omega_1$$

$$\eta_{is} = \frac{2u}{c_0^2} \times 1.85\, \omega_1 \cos \beta_1$$

Since $\omega_1 \cos \beta_1 = c_1 \cos \alpha - u = 0.95\, c_1 - u = 0.9025\, c_0 - u$, we obtain

$$\eta_{is} = \frac{3.7u}{c_0^2}(0.9025\, c_0^2 - u) \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

From Equation [2] are constructed the efficiency curves of Fig. 24 for the pure impulse turbine. From this the author proceeds to the consideration of combined impulse and reaction turbines with the degree of reaction ρ, which will be abstracted in the next issue. (Om Skevelverkningsgrader vid Aktions- och Reaktionsangturbiner, Professor Tore G. E. Lindmark, *Teknisk Tidskrift, Mekanik*, vol. 49, no. 24/3, March 12, 1919, pp. 37-41, 3 figs. *tA*, to be continued.)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

THE STILL ENGINE

ENGINEERS who chanced to read the New York *Times* of May 28 had their curiosity aroused by a special cable dispatch from London under the heading, "New British Engine Surpasses the Diesel," giving a brief account of a paper read the previous day before the Royal Society of Arts on the Still engine, a combined internal-combustion and steam motor for which a thermal efficiency of 50 per cent was claimed. This paper, by Capt. F. E. D. Acland, was published in the *Journal of the Royal Society of Arts* of June 6, from which the following extracts and illustration, giving an idea of what it is claimed has been accomplished, have been taken.

The possibility of combining in one engine the superior thermal cycle at the high temperatures and pressures of the combustion engine with the low thermal cycle of steam to deal with its rejected heat, and in the same engine to add the superior working advantages of the steam engine, is the basis of work carried out by Mr. W. J. Still.

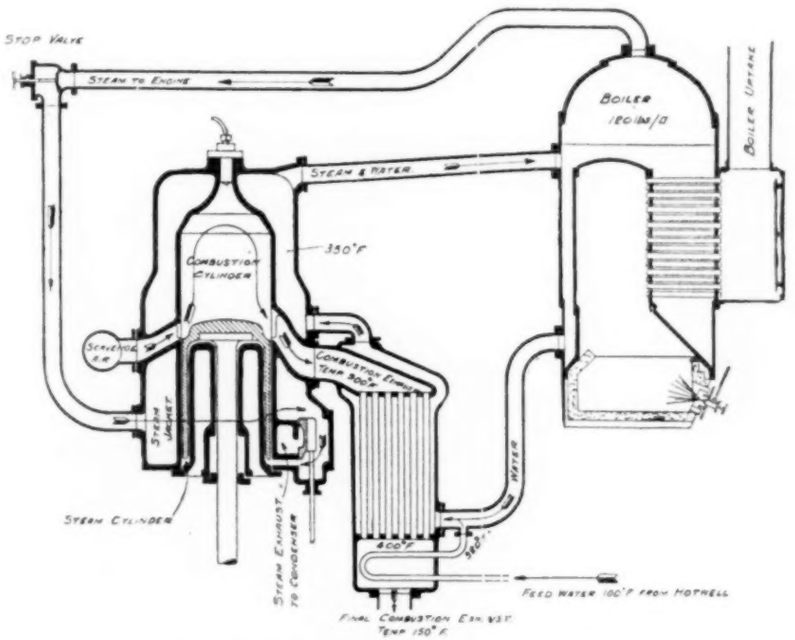


DIAGRAM SHOWING ARRANGEMENT OF STILL ENGINE

The Still engine is an engine capable of using in its main working cylinder any form of liquid or gaseous fuel hitherto employed; it makes use of the recoverable heat which passes through the surfaces of the combustion cylinder, as well as into the exhaust gases, for the evaporation of steam, which steam is expanded in the combustion cylinder itself on one side of the main piston, the combustion stroke acting on the other side. It increases the power of the engine and reduces the consumption of the fuel per horsepower developed.

Its primary object is not to use the waste heat for raising steam, but first to use it in improving the thermal conditions of the working cylinder, and so insure the maximum efficiency from the fuel burnt within it, diminishing as a consequence the heat lost in that operation. Since the maximum efficiency is obtained by combustion of the fuel in the cylinder, and the minimum by the evaporation of the water in the steam generator, it is evident that the larger the quantity of steam which can be generated per horsepower developed by the combustion cycle, the lower must be the heat efficiency of the whole machine.

In the Still engine—see diagram—the jacket and cooling water form part of the circulating system of a steam generator, which may be an integral part of the engine, or external to it. The cooling water therefore enters and leaves the jacket at a constant temperature, regulated by the pressure of the steam, the cooling being effected by converting the water into steam without raising its temperature. Excluding the radiation losses, which are kept low by lagging, all the heat which passes through the walls is thus usefully recovered in the water as steam. The temperature of the cylinder wall is uniform over the whole of its exterior surface, and the heat lost to the cooling water at each stage of the cycle—compression, combustion and expansion—is diminished.

The exhaust gases after raising their quantum of steam are employed in preheating all the water required for the steam generated in the jacket water and the generator. Trials at full efficiency over long periods and steady loads show terminal stack temperatures as low as 150 deg. fahr.

The quantity of steam capable of being generated from "waste heat" depends on the efficiency of the combustion cycle and the load. Some years of experimental work prove that the weight of steam recovered may attain a maximum of about 7 lb. per b.hp-hr. developed by the combustion cycle of a four-stroke constant-volume engine at full load.

The first experimental engine constructed was a two-stroke engine capable of developing 500 b.hp. from three cylinders at 400 revolutions, bore 8 in. It was a high-speed engine, designed with special regard to obtaining data about the recovery of steam from waste heat (jacket and exhaust). It was first operated on town gas—540 B.t.u. per cu. ft., and subsequently converted for oil fuel. Its efficiency was not high, owing to its being a two-stroke engine with a short stroke, but its consumption per brake horsepower was 15 cu. ft. per hr. (31.3 per cent efficiency), a very promising result.

The outbreak of war prevented much progress being made in the design and construction of gas engines; but the results achieved give great promise of future development, for with a combustion indicated efficiency of 36 per cent, radiation 4 per cent, boiler loss 10 per cent, there remains 50 per cent for recovery; allowing 10 per cent efficiency for the steam cycle, a gain of 5 per cent is assured, and the total indicated efficiency of the engine will not be less than 41 per cent. If 20 per cent efficiency is obtained from the steam cycle, as appears possible, the total indicated efficiency will be 46 per cent.

A gas engine which can give a brake thermal efficiency 30 per cent better than its predecessors, and which, by governor control alone, can meet any demand up to and over 100 per cent overload, while maintaining a good efficiency at that increased output, cannot be neglected.

Four-stroke engines for petrol and similar fuels have been built and tested ashore and afloat. A special 13½ by 22-in. two-stroke-cycle heavy-oil engine with opposed pistons has been subjected to long and varied tests by representatives of various governments. The combustion takes place between the pistons, the steam acting on the return stroke at the back of both pistons. The best consumption of fuel—Admiralty shale oil—was as low as 0.302 lb. per b.hp. (scavenge pump not included) over a test of 1 hr. duration. This engine developed 330 b.hp. for 6 hr. at 360 r.p.m.—a single cylinder under waste-heat conditions. It will develop 400 b.hp. continuously with added steam—generated by fuel under the boiler—and has developed 540 b.hp. at 380 r.p.m. over short periods. (Combustion m.e.p., 128.2 lb.; steam m.e.p., 57.9 lb.; total m.e.p., 186.1 lb.) The thermal brake efficiency from below quarter load to full power is maintained at approximately 40 per cent over the whole range.

The application of the Still system to commercial marine work is being developed in this country and abroad, the two-stroke single-piston type, in powers of 100 hp. per cylinder and 400 hp. per cylinder, having been adopted. Engine of this type at 120 r.p.m., with a 22 by 36-in. cylinder, giving 4200 shaft hp. on two shafts, with all auxiliaries and water would approximate 600 tons. A geared turbine plant in a similar ship would weigh 20 per cent more and would consume approximately 2000 tons more fuel for a double journey lasting 1000 hours.

Bureau of Standards Publications

Circular 79, issued by the Bureau of Standards and prepared by G. W. Vinal and H. D. Holler, summarizes the available information on dry cells. A brief description is given of the materials and methods of construction, and an elementary theory of the operation of the cells. The various sizes and kinds of dry cells on the American market are described. The electrical characteristics of the cells and methods of testing them are discussed. In an appendix are given the proposed specifications for dry cells which have been prepared by the Bureau.

A second pamphlet, Technological Paper No. 109, gives practical suggestions for the conservation of tin in bearing metals, bronzes, and solders; much of the data having been obtained from questionnaires sent to representative manufacturers and users of these alloys. Tables are given showing the chemical composition and physical properties of many of the suggested alloys, and also for service tests of genuine babbitt and a high-lead bearing metal. Tentative recommendations for standard grades of bearing metal are also included.

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

M. E. COOLEY, *President*
WILLIAM H. WILEY, *Treasurer* CALVIN W. RICE, *Secretary*

PUBLICATION COMMITTEE:
GEORGE A. ORROK, *Chairman* J. W. ROE
H. H. ESSELSTYN GEORGE J. FORAN
RALPH E. FLANDERS

PUBLICATION STAFF:
LESTER G. FRENCH, *Editor and Manager*
LEON CAMMEN, C. M. SAMES, *Associate Editors*
W. E. BULLOCK, *Assistant Secretary Editor Society Affairs*
FREDERICK LASK, *Advertising Manager*
WALTER B. SNOW, *Circulation Manager*
136 Federal St., Boston

Yearly subscription $3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries $1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

The Detroit Meeting

The significant fact in connection with the Detroit meeting was the sustained interest in the professional and business sessions, from start to finish. The meeting opened on Monday, a day earlier than usual, and the business meeting was held on that day instead of the morning following, which virtually lengthened the period of the convention by one day. Nevertheless, a large number were on hand for business on Monday and stayed through the closing session on Thursday, which was one of the largest attended sessions of the meeting. The discussion at the various sessions was unprecedentedly large, that on Aims and Organization alone extending over a period of three days, and on Research for a full day. This number of MECHANICAL ENGINEERING features reports of the Aims and Organization and the Industrial Relations sessions, while the August issue will report the Research and Pulverized Fuel sessions. In order to include the report, this number of MECHANICAL ENGINEERING is issued one week later than usual, as announced on page 552 of the June number.

The Engineering Index

In this number of MECHANICAL ENGINEERING an alphabetically-arranged index has been added to the items listed in the Engineering Index, in order to enhance its reference value.

When the Engineering Index was published by its former owners, the items were classified under the subject system. In taking over the Index, The American Society of Mechanical Engineers decided to retain the system of classification in order to test out the opinion of the membership as to its practicability. Experience has shown, however, that opinion is at least divided and that the alphabetical or dictionary arrangement of the items listed would be preferred by many members.

Because of the suggestions of the alphabetical arrangement which have come to us, it was decided to add the alphabetical index already mentioned until such time as a more decided preference can be expressed by our readers for the particular manner of arrangement for the Index items. The Editor of MECHANICAL ENGINEERING will be glad to hear from members as to what they think is the relative desirability of the classified and alphabetical systems of listing items in the Index.

Report of the Nominating Committee

The following report has been received from the Nominating Committee appointed by President Cooley earlier in the year and which met at Detroit on June 16:

TO THE SECRETARY:

The Committee appointed by the President to nominate candidates to be balloted upon at the next annual election of the Society report a unanimous selection as follows:

For President:
FRED J. MILLER, New York, N. Y.

For Vice-Presidents:
R. H. FERNALD, Philadelphia, Pa.
E. C. JONES, San Francisco, Cal.
J. R. ALLEN, Pittsburgh, Pa.

For Managers:
D. S. KIMBALL, Ithaca, N. Y.
E. F. SCOTT, Atlanta, Ga.
E. C. FISHER, Saginaw, Mich.
} Three-year term.
C. E. LORD, Chicago, Ill.: One-year term to complete term of Fred A. Geier—resigns December, 1919.

For Treasurer:
WM. H. WILEY, New York, N. Y.

Respectfully submitted,
(signed) T. H. HINCHMAN,
JOHN V. MARTENIS,
H. J. O. HINCHEY,
ROBERT SIBLEY,
A. G. CHRISTIE,
Nominating Committee.

Detroit, June 17, 1919.

Anniversary Dinner for John A. Stevens

In celebration of the completion of a decade of successful business, an anniversary dinner was tendered to Mr. John A. Stevens, Engineer of Lowell, Mass., Vice-President of the A. S. M. E. and Chairman of its Boiler Code Committee, by his associate engineers and assistants at the Hotel Thorndike in Boston, Mass., on the evening of Saturday, May 17. About forty members of the organization were present and an informal reception was given to Mr. and Mrs. Stevens before the dinner.

The items on the menus, or "Fundamental Data" as they were called, were humerously couched in engineering terms, and the attractive front covers bore illustrations of one of the first plants built in 1909 and of a very large proposed super power house—recently designed in Mr. Stevens' office.

In the course of the evening the guest of honor was presented with a loving cup on behalf of the members of the organization, and received congratulatory letters and telegrams from many of his personal friends and clients. Mrs. Stevens was presented with a large bouquet of roses.

The associate engineers in Mr. Stevens' office are Messrs. Walter Slader, Clarence A. Bowen, Clarence Reeds, Francis Cunningham, Harry C. Lord, Carl J. Sittinger, George H. Thorpe and Marcus K. Bryan.

Services Acknowledged

At the request of the National Research Council, the Society, through its Standards and Technical Committee, has been privileged at various times during the past six months to furnish the French Government with information concerning American engineering and industrial standards. In all, nearly 200 publications have been transmitted (mostly in duplicate), embracing copies of engineering and safety standards and codes of the various engineering societies, publications of the American Pharmaceutical Association, chemical, mining and mechanical equip-

ment catalogs, and specifications and working drawings of United States standard locomotives and rolling stock. That the material thus collected and sent has been helpful, is evidenced by the letter reproduced below, which was recently received by the Society.

OFFICE OF THE SCIENTIFIC ATTACHE TO THE AMERICAN EMBASSY,
4, Place D'Iena

PARIS, May 26, 1919

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS,
NEW YORK, N. Y.

GENTLEMEN:

The material collected by you for the French Government on the United States engineering and industrial standards has been received and transmitted to the services interested.

I wish to take this opportunity of thanking you in behalf of the French Ministry for the very comprehensive and valuable mass of material which you have assembled and put into convenient form for use. It will certainly be of great value here where standardization in the industries is in a very rudimentary state and where an organized attempt is now being made to introduce order into the engineering practice.

Very truly yours,
(Signed) H. M. HOWE.
Scientific Attaché.

Honor for George Ellery Hale

George Ellery Hale, Director of the Mount Wilson Observatory and Foreign Secretary of the National Academy of Sciences, who has been for the last ten years a Correspondent of the Académie des Sciences, Institut de France, has received the unusual honor of election as Associé Étranger, taking the place of Adolph von Baeyer, declared vacant by the Academy. The Foreign Associates are limited to twelve, and the high distinction has been held by only two Americans—Simon Newcomb and Alexander Agassiz.

The National Research Council, upon the presentation and acceptance of Dr. Hale's resignation as its chairman and the election of James R. Angell as his successor, created and bestowed in perpetuity upon Dr. Hale the title of Honorary Chairman in recognition of his services to the National Research Council and to science and research by indefatigable efforts that have contributed so largely to the organization of science for the assistance of the Government during the war, and the augmentation of the resources of the United States through the newly intensive cultivation of research in the reconstruction and peace periods that are to follow.

Cleveland Engineering Society Honors A.S.M.E. Members

The Cleveland Engineering Society at its annual meeting on June 10 conferred Honorary Membership upon Dr. Charles F. Brush, Member A. S. M. E., and Worcester R. Warner, Past-President A. S. M. E. Dr. Brush was honored because of the important contributions he has made to the field of electrical engineering. He was the inventor of the arc lamp and many electrical devices.

Mr. Warner's connection with the machine-tool industry and his contributions to the science of astronomy are well known. In collaboration with Mr. Ambrose Swasey, his work represents the most notable development in the design and construction of telescopes and other instruments of precision for astronomical observation. The three great refracting telescopes, including the 36-in. Lick, the 40-in. Yerkes, and the 26-in. U. S. Naval, were all the products of his firm.

Summer School of Industrial Management

The fourth summer session in factory organization, cost accounting, employment and scientific management will be held at Pennsylvania State College, State College, Pa., August 11 to 23.

The mornings will be devoted to lectures and discussions on organization, cost accounting and employment management and will be conducted by Major Hugo Diemer, Mem. Am. Soc. M. E., formerly professor of industrial engineering at the college and now superintendent of personnel, Winchester Repeating Arms Co. During the war Major Diemer served in the Ordnance Department, where he was in charge of important munitions work at the U. S. Cartridge Co. and the Bethlehem Steel Co.

The afternoon practice work in making time and motion studies, routing, scheduling, etc., will be in charge of Lieut. J. C. Keller, Jun. Am. Soc. M. E., Major Diemer's first assistant in industrial engineering instruction at the college. A fee of $25 is charged for the course and equipment is available for a class of 30 students.

Labor and Scientific Research

Mention was made in the June number of MECHANICAL ENGINEERING (page 558), of the organization of scientific and technical employees of the Government as a branch of the National Federation of Federal Employees, which is affiliated with the American Federation of Labor. Immediate cause for this movement was the action of the Joint Congressional Commission on Reclassification of Salaries of Federal Employees, this Commission preferring to deal with organizations rather than with independent groups. It is noteworthy that one of the first accomplishments of the new organization has been the securing of the adoption by the American Federation of Labor at its Atlantic City meeting of resolutions favoring scientific research as the basis for increased productivity in the industries and the promotion of the health and well-being of the employees—a recognition of fundamental principles, which, until recently, labor has seldom been willing to accept. The resolutions were introduced at the convention jointly by the National Federation of Federal Employees and by the American Federation of Teachers. The most important clauses embodied are given below:

The American Federation of Labor adopted the following resolution at its Atlantic City convention:

WHEREAS, Scientific research and the technical application of results of research form a fundamental basis upon which the development of our industries, manufacturing, agriculture, mining, and others, must rest; and

WHEREAS, The productivity of industry is greatly increased by the techincal application of the results of scientific research in physics, chemistry, biology, and geology, in engineering and agriculture, and in the related sciences; and the health and well-being not only of the workers but of the whole population as well, are dependent upon advances in medicine and sanitation; so that the value of scientific advancement to the welfare of the nation is many times greater than the cost of the necessary research; and

WHEREAS, The increased productivity of industry resulting from scientific research is a most potent factor in the ever-increasing struggle of the workers to raise their standards of living; and the importance of this factor must steadily increase since there is a limit beyond which the average standard of living of the whole population cannot progress by the usual methods of re-adjustment, which limit can only be raised by research and the utilization of the results of research in industry;

RESOLVED, By the American Federation of Labor in convention assembled, that a broad program of scientific and technical research is of major importance to the national welfare and should be fostered in every way by the Federal Government, and that the activities of the Government itself in such research should be adequately and generously supported in order that the work may be greatly strengthened and extended.

American Drop Forge Association

Progress in the establishment of standards for forgings was reported at the sixth annual convention of the American Drop Forge Association held at Pittsburgh, June 12-14, by the committee on standardization, which since the signing of the armistice has investigated the allowable limits for automobile crankshafts, gears, camshafts, connecting rods and axles. In his presidential address, E. J. Frost, Jackson, Mich., laid stress on this subject of standardization which, he observed, affords the greatest opportunity for eliminating waste and improving undesirable conditions.

W. O. Renkin, New York, read an interesting paper on Development in the Use of Powdered Coal in the Forging Industry, in which he claimed that the principal requirement of a furnace to burn powdered coal successfully is a relatively large combustion chamber of proper design. By proper design he

meant one which allowed the particles of coal to combine properly with the correct amount of air and burn at a minimum pressure above precipitation.

Earl E. Adams, Dayton, Ohio, spoke on Producer Gas as a Forge-Shop Fuel, and said that the gas must be cold to reduce the moisture and clean to prevent the clogging of the mains. He referred to a glass-wool tar extractor said to have an efficiency of from 99.95 to 99.98 per cent and made up of a mat of glass wool or spun-glass thread. A 20-in. mat, capable of handling 20,000 cu. ft. of gas an hour, contains 300 miles of this spun-glass thread. When made into a mat it is equivalent to 250 plies of 90-mesh screen.

Other technical topics were: Forge-Shop Profits, by F. A. Ingalls, Harvey, Ill.; Sand Blasting Versus Pickling, by R. R. Shuman, Chicago; Die Cost as a Factor in Selling Forgings, by R. T. Herdgen, Walkerville, Ont.; Heat-Treating Problems That Originate in the Forge Shop, by W. C. Peterson, Detroit, Mich., and Fusion Welding as Applied to Drop Forgings, by S. W. Miller, Rochester, N. Y.

A Word from Roberts College

The A.S.M.E. headquarters was recently favored by a call from Prof. Lynn A. Scipio, Mem.Am.Soc.M.E., Director of Engineering of Roberts College, Constantinople. Plans are under way for the expansion of the engineering school, and Professor Scipio is here to recruit a teaching staff.

Some one has said that the only good thing that has happened in Turkey is Roberts College; and certain it is that it has been the most potent civilizing and educational influence in that country and throughout the Balkan states.

In this work the engineering school is assuming an important place. The original plans for the school were made by Prof. John R. Allen, Mem.Am.Soc.M.E., in 1911 and 1912. He was followed by Professor Scipio, who went from the University of Nebraska to develop the school. Three courses have been offered in Civil, Mechanical and Electrical Engineering, and a course in Mining is contemplated. A shop building with limited equipment has been erected and a power plant at a cost of $100,000.

The college was able to remain open during the war, although its courses were curtailed. When diplomatic relations were broken off with Turkey, the United States Government ordered its citizens out of the country. A few remained at the college, however, and carried the work with the aid of native instructors. Frequent attempts were made both by the Germans and Turks to confiscate the buildings for other purposes, but these were thwarted through the diplomacy of the college president, Dr. C. F. Gates. The Germans dominated the situation and were in every office, and finally attempted to starve out the college by making flour contraband on the ground that it was needed by the army. The engineering department then proceeded to build a flour mill, which was successful in tiding over the situation.

Coal was bought for the power plant at $80 and $100 a ton, although much of it consisted only of earth scrapings from the bottoms of former coal piles, and was worthless. Money for the continuance of the college was secured mainly through personal contributions by Greeks and Armenians. Notes were sold at 2 per cent interest, which were readily disposed of, as it was felt that the college was sound and would be well supported financially, and many natives believed it provided a safer investment for their money than any other institution.

16 Hours, 12 Minutes

Since the NC-4 of the United States Navy has shown the way across the shorter part of the Atlantic there have been several highly significant developments.

The Sopwith biplane with Hawker and Grieve started from Newfoundland, but was not able to complete the crossing owing, as has been stated, to minor troubles in the water-circulation system of the engine. The plane had to land on the water after a flight of little in excess of 1000 miles, but the pilot and navigator were saved by a passing steamer.

Another attempt on Sunday, June 15, made by Capt. John Alcock and Lieut. Arthur W. Brown, British officers, in a Vimy biplane was successful and the two fliers crossed the Atlantic from Newfoundland to Clifden, Ireland, in 16 hours and 12 minutes.

The events of the last four weeks taken in their entirety point to several significant facts. In the first place, altogether five machines made this attempt—three in the shorter southern direction and two in the longer northern direction, and only two of the five have reached their goals, the other three landing on the water. Nevertheless, not a soul was lost in these flights, and even the dare-devil attempt of Hawker and Grieve has ended with all hands safe. This would indicate essentially that flying over an ocean upon which so many vessels are constantly plying as on the Atlantic along its trade routes is probably less dangerous than would appear at first sight.

The second lesson brought out by the flight of Alcock and Brown lies in the fact that they had to cross the ocean under unusually trying conditions, and succeeded in doing so, nevertheless. It would appear from this that even in the present state of long-distance aerial transportation a flight 1900 miles is practically achievable, and if the tremendous strides made in aerial navigation in the last years be considered, it will become fairly obvious that ere long the establishment of regular aerial transportation across the ocean may be expected.

It may well be pointed out here that these transoceanic flights represent really the first obviously important commercial application of aircraft. At present and for the first few years to come, there is no question but that air transportation will be considerably more expensive than all other existing means of transportation, not only because it necessitates the use of a heavier fuel but also because the depreciation of the machinery used per pound of weight carried is greater than in the case of motor trucks, railway trains, or steamboats.

The only point where air transportation is unquestionably superior to any other form of transportation is in its speed, but even in land transportation the superiority of aircraft speed is not great enough in a good many cases to compensate for its higher cost. Thus, taking such two points as New York and Chicago, air communication would only in comparatively few cases be fast enough to save even one business day between these cities.

The situation, however, is entirely different with transatlantic transportation. While there are one or two boats that can make the passage in five days and some hours, the average time from Liverpool to New York is between six and eight days, which means that all fast transportation of messages must depend upon the cables and wireless. With a 24-hour schedule between London and New York it would be perfectly possible to receive London papers in time for abstracting them in New York papers of the next day, while letters between London and New York would be delivered as promptly as they now can be between New York and Chicago.

In banking, important business transactions and especially in engineering enterprises the ability to send a draft or a blueprint from New York to London or back in 24 hours will not only be a great help to the growing American export trade but will also create an important source of business for the aerial navies of the near future.

Edwin J. Prindle, A. S. M. E. representative on the Patent Committee of the National Research Council and who presented a paper at the January 14 meeting of the New York Section dealing with the movement to increase the efficiency of the Patent Office and the patent system (see MECHANICAL ENGINEERING, February 1919, p. 147), has just been appointed Chairman of the Patent and Related Legislation Committee of the American Chemical Society.

At the recent convention of the National Association of Manufacturers, addressed by Mr. Prindle on the subject, a resolution was passed approving the report of the Patent Committee of the National Research Council to that body and the enactment of its legislative program.

THE DIVISION OF ENGINEERING OF THE NATIONAL RESEARCH COUNCIL

AT the Research Session of the Spring Meeting of the A. S. M. E., an address was given by Mr. Galen H. Clevenger, Acting Chairman of the Division of Engineering of the National Research Council, on the organization and work of the Council and of the Division of Engineering with which he is directly connected, at present in charge of the headquarters of the Division of Engineering in the Engineering Societies Building, New York.

Mr. Clevenger reviewed the organization of the National Academy of Sciences which came into being during the Civil War through the action of President Lincoln; and of the National Research Council which similarly was organized during the present war at the request of President Wilson. Lately, the National Research Council has been reorganized on a permanent basis for promoting research among the industries of the country.[1]

In his address Mr. Clevenger also reviewed the war organization and work of the Division of Engineering, followed by an account of the present activities and affiliations of the Division of Engineering, from which the following is taken:

War Organization of Division of Engineering

The Division of Engineering comprised four sections: A section on Metallurgy, a section on Mechanical Engineering, a section on Electrical Engineering and a section on Prime Movers. The work of each section was under a chairman, who was directly responsible to the chairman of the division.

The Section on Metallurgy had for its principal work the solving of metallurgical problems arising in connection with the conduct of the war, more particularly those brought to it by the military. This work was accomplished through the medium of committees, whose personnel included leading authorities upon metallurgy.

The Section on Mechanical Engineering established a drafting room in charge of a chief draftsman, at Research Council headquarters and through the generosity of the Carnegie Institute of Technology a machine shop at Pittsburgh under the direction of a foreman. These were used for the development of inventions referred to the Section by the Divisions of Engineering and Physics.

The Section on Electrical Engineering concentrated its efforts upon the problem of electric welding, more especially electric welding as applied to ship building. This section worked in very close coöperation with the Emergency Fleet Corporation, who financed its investigative work.

The Section on Prime Movers devoted its attention chiefly to the design and development of power plants for aircraft.

The efforts of each section were so directed as to be of the greatest service in the solving of the problems of greatest immediate need to winning the war; each has to its credit important achievements during the war period. (See Report of the Academy of Sciences for the Year 1918.)

Present Organization and Affiliations

The purpose of the National Research Council is to promote research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare. Affiliation with similar organizations abroad is rapidly bringing about an International Research Council.

The Division of Engineering consists of three representatives of each of the four founder engineering societies, the societies so represented being the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Further, there is one representative each from the four more important non-founder societies, the societies so represented being the American Society for Testing Materials, the American Society of Illuminating Engineers, the Western Society of Engineers, and the Society of Automotive Engineers. In addition to the representatives of the engineering societies there are 12 members at large, making a total membership in the division of 28. Eight members of the division are also members of Engineering Foundation.

The Engineering Foundation has from the beginning taken a very active and important part in furthering the work of the whole council; indeed in the earlier stages of the war organization, when the funds available for carrying on its work were very limited, Engineering Foundation gave the services of its secretary and substantially its whole income to the support of the Council, this arrangement continuing until support was secured from other sources.

Recently a plan of close affiliation of the Engineering Foundation and the Division of Engineering has been approved by the members of the Engineering Foundation and the Division of Engineering, and also by the Executive Board of the Council. In compliance with the terms of this agreement the Engineering Foundation has provided the Division of Engineering with an office in the Engineering Societies Building, New York, together with necessary clerical assistance. It further has agreed to make appropriations of its funds to aid specific undertakings of the division from time to time as may be later determined; and in fact at the present time an arrangement has been practically effected whereby the Engineering Foundation undertakes the financial support of the work of the Committee on Fatigue Phenomena in Metals.

The location of the Engineering Division in the same building with the headquarters of the national engineering societies and its close affiliation with the Engineering Foundation renders it a very potent factor in promoting engineering research.

The Engineering Division is not to be regarded as an instrument of research, but rather a stimulator and coördinator of research. It is not the master but the servant, eager to aid in the bringing together of research agencies and uniting them in larger projects of research than would be possible through individual effort. Its principal object is to get more and better research done in engineering, carefully avoiding the position of being a dictator, or of assuming credit for work which it has encouraged others to do.

The Engineering Division is at present carrying on its work largely through the medium of committees. Much thought has been devoted to developing a plan of organization of research committees which will render them most effective. It is clearly recognized that within every committee there should be an active group which is in a position to do the actual work of research. A chairman is provided who is thoroughly familiar with the subject in hand and who has sufficient time to devote to the work; furthermore, financial support necessary to carry on the work is provided so far as possible. When all of these conditions are provided for, effective work may be expected from the committee, even though the larger group of the committee may be busy men who can do little more than act in an advisory capacity.

The Engineering Division now has some 14 committees working upon a variety of subjects. These are in various stages of organization.

Every effort is being made to take up researches of broad general interest. At present 21 states, extending from the Atlantic to the Pacific, are represented on these committees and the number is rapidly increasing.

[1] For further references to the history and organization of the National Research Council see pamphlet copy of Mr. Clevenger's address; also the following references to MECHANICAL ENGINEERING: May, 1919, p. 485; June, p. 559; and the present issue, p. 592.

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

Classification and Compensation of Engineers

THE Committee on Classification and Compensation of Engineers, whose personnel was given in the May issue of MECHANICAL ENGINEERING (p. 488), is now actively engaged in securing data upon which to base its final report. This committee is divided into three sections, Federal, Railroad, and Municipal and State. Preliminary reports were recently rendered by each and in submitting them to Engineering Council the Committee outlined its method of procedure in attempting to formulate standard rates of compensation for professional engineers. The first task is to find what rates are actually in force, especially in those fields where attempts at standardization have been made, and the second is to inquire what adjustment should be made to correspond to the great change which has taken place in the cost of living. How great this change has been during the past 20 years is realized by few. Fortunately an accurate determination is available in the statistical records of average prices which for many years have been gathered and published by leading commercial organizations. A record of average prices of the necessaries of life kept by R. G. Dun & Co., shows that prices have increased continuously for 22 years. A certain quantity of staple necessaries which could have been purchased July 1, 1897, for $72.45, by January 1, 1905, cost $100.32. On January 1, 1914, before the outbreak of the war, the cost had risen to $124.53; May 1, 1917, to $208.43, and October 1, 1918, to the maximum of $233.23. This enormous increase in prices of the necessaries of life has been accompanied by an increase in wages, among workers organized in unions which had the power to compel attention to their demands, but no such increase has taken place in the compensation of salaried workers in the professions. It has been assumed that these workers, living in a different social environment, had a margin of compensation sufficient to enable them to meet the increased cost of living. This assumption, however, is not justified by the facts. Where salaries have been increased during the past three years, there are few cases in which the increase has been at all commensurate with the increase in prices of the necessaries of life, which the salaried worker, like the wage worker, has had to purchase.

There has been a general belief that with the coming of peace and the resumption of productive industries, a heavy fall in prices would occur. It has been assumed that the salaried worker would have to wait for this so that he could again live within his income. It now appears, however, to be the opinion of many financiers and economists that the present high prices of necessaries are likely to continue for a long time, probably for several years. If this is so, then surely the salaried worker, in a professional or any other occupation, has an equitable claim to have his compensation brought back in purchasing power to where it was fifteen years ago.

There is another aspect of the compensation of the professional worker which has been frequently misunderstood, but which with present knowledge ought no longer to deceive. The pay of professional engineers has for many years been influenced by the idea that a young man in the earlier years of his work should expect moderate compensation because of the future to which he might look forward. There was justification for this idea during the period when the development of engineering was so rapid that a large proportion of the men who were turned out from the few engineering schools or the engineering workshops were able eventually to rise to positions of large responsibility and importance, commanding high salaries. That condition has now been altered. Of the men who begin technical engineering work today, only a very few selected ones can rise to positions of responsibility commanding high salaries. The man of exceptional ability, indeed, may find it worth his while to work for low compensation because of the future awaiting him. But to hold up to the rank and file of technical workers the idea that they can afford to work for insufficient salaries for the sake of some future high position, is a gross deception.

The Committee believes, therefore, that in adopting standards for the compensation of workers in all technical fields due consideration should be given to the great increase in the cost of living. The dollar of salary must be considered with regard to what it will purchase today and is likely to purchase next year, and not with regard to the value of the dollar ten or fifteen years ago. This increase in compensation is necessary not merely as a matter of justice to the engineer, but in order that engineering work may be maintained on the plane that it must be to secure economical and efficient work. There is no economy in paying such men at rates inadequate for their support, for this leaves their minds burdened with anxieties, when they should be free to give their best efforts to the work in hand. Moreover, such a rate automatically tends to drive the abler men into other occupations and to leave in charge of the work only those of less ability. The Committee has therefore recommended that it be directed to formulate a definite classification for each of the services under consideration and a schedule of compensation which might reasonably be fixed for positions in each class.

Federal Government Section. A survey of Government activities shows that there are twenty-eight offices that employ Government engineers. A letter was sent to each departmental secretary outlining the work of the Committee and requesting assistance in furnishing a list of engineering bureaus in his department and in issuing instructions to the chiefs to furnish the needed data. Favorable responses from all departments were received, except the War Department, which stated it would be impracticable to furnish the information desired. But little work has been done, however, as an analysis of the data collected cannot be made until the majority of the reports have been received.

Railroad Section. The chairman of this section prepared a questionnaire to be sent to the chief engineers of the railroads under Federal control on the supposition that the salaries of all the men in the various departments of the Railroad Administration were a matter of public knowledge, and also requested recommendations on an unofficial basis from them. Before sending out this questionnaire, however, the chairman made a personal call on Director-General Hines and discussed with him the propriety of making such a request. Mr. Hines did not think that the matter should be approached in the manner suggested, nor that the employer should be called upon to furnish a list of salaries and to express in advance an opinion as to how these salaries should be changed; but did state that he did not see any objection to our getting the information from members of the Founder Societies. The chairman acquiesced in Mr. Hines' views, and has accordingly confined his questions to members of the Founder Societies.

Municipal and State Section. By reason of the wide variety of titles used for the municipal and state service, the Committee found it necessary to undertake the formulation of a standard classification of positions and duties, before attempting to investigate the question of compensation. The assistance of the Municipal Engineers of The City of New York was invoked in this particular, and after a painstaking investigation by a representative committee a schedule of suitable titles with corresponding qualifications and duties has been prepared. The fitness of this schedule for general use is now under consideration by the Committee. As soon as an agreement shall have been reached, it is proposed to incorporate it in a questionnaire for circulation among the engineers of all states and the more important cities, with a view to determining present compensation and changes which should be made. It is hoped that the classification finally agreed upon will prove broad enough to cover all municipal and state engineering service, and that it will be accepted as a substitute for the variety of standards now in use.

[1] Officers of Engineering Council: J. Parke Channing, *Chairman*; Alfred D. Flinn, *Secretary*, Engineering Societies Building, 29 West 39th Street, New York.

NATIONAL SERVICE COMMITTEE

Contributed by the Washington Office[1]

National Department of Public Works

THE proceedings of the conference held at Chicago, April 23 to 25, to consider the formation of a Department of Public Works were published in the June issue of MECHANICAL ENGINEERING, p. 557. Since then the work in general has been divided into four parts:

Organization of Executive and Finance Committees
Drafting of a bill
Organization of a Campaign Committee
Review of public-works laws of other countries.

The Committee on Text of Bill has completed its labors. After approval by the Executive Committee it is the intention to consult leaders in Congress and secure advice as to its introduction. After it is introduced and has thereby gained official status, copies will be freely distributed among the various federated organizations. Suggestions concerning amendments will then be solicited.

The review and compilation of public-works laws of other countries is also practically completed, covering all the larger powers, three British dominions, four South American republics, and several small European kingdoms.

The organization of the Campaign Committee has been a huge task and is by no means completed. It was apparent at the outset that a committee would be required consisting of one or more members from each state in the Union. It is impossible to make such a committee function as a unit and therefore it was determined, subject to approval of the Executive Committee, to create separate state committees, all synchronizing with the Washington office. Campaign conditions vary widely in the several states and residents in each state are better qualified to determine details of campaign than any general committee. The Chairman has written several hundred original letters to men in the several states urging them to undertake the campaign work. Many replies, both favorable and unfavorable have been received, but from the majority of the states no responses have been returned. Formation of committees is now under way in New England, New York, Ohio, Michigan, Wisconsin, Minnesota, Illinois, Kentucky, Missouri, Kansas, West Virginia, Georgia, Florida, Louisiana, Texas, Nebraska, North Dakota, Arizona, California, Washington, Oregon, and Idaho.

It seems wise in the conduct of this campaign to avoid the outworn and objectionable methods that have been followed by practically everyone during the past generation. The very character of the project and the standing of those participating in it demand that the campaign shall be conducted on a high and dignified plane. It should be the duty of the several state camapign committees to select in each congressional district men qualified to give advice along such lines. The Washington office should supply the particular facts, instances and arguments that are apparent to everyone on detailed study, but which may or may not be familiar to those who approve the project on general principles.

It is not expected that a campaign of any kind can be immediately successful, but it is believed that the open and aboveboard procedure here outlined, steadily and progressively maintained, will result in the making of fast friends in official circles and in bringing a successful conclusion sooner and with less acrimony than any other method now apparent.

Relations with Congress

In order to introduce Engineering Council to members of Congress and to make known its purposes, the following letter has been addressed to the chairman of twenty-eight committees of the House and Senate. Appreciative acknowledgments have been received from a large number of them.

This is addressed to you on behalf of Engineering Council for the purpose of informing you concerning its aims and purposes, and of ways in which it may be useful to you in your official capacity.

Engineering Council is the central organization, made up of representatives appointed by the various national societies and institutions of engineers, including the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Society for Testing Materials. These national societies have focused their common aims and affiliations in Engineering Council, and said Council represents the highest type of engineering thought and experience in the United States.

One of the chief aims of the Council is that of national service. It proposes to lend its services to the Government when so invited, and to give counsel and advice on engineering matters. By this announcement it is desired to inform you that, if in your official capacity, you wish to secure the unprejudiced assistance of a body which comprises within its membership and affiliations the best qualified engineering authorities of the country, you have merely to make your desires known and Engineering Council will place at your disposal a group of men which will merit your entire confidence. Such service will naturally have to be confined to counsel and advice as to policies and plans.

It is hardly necessary to add that no compensation will be asked or expected for such service, the aim of Engineering Council being to give its services to the country and thereby contribute its appropriate part to the general well-being.

Government Contracts

The National Service Committee has placed before Engineering Council the matter of a uniform type of construction contract for use by Government agencies. At present there is a heterogeneous mixture of many kinds of contracts, from the old-fashioned lump-sum bid to the more complicated, so-called "cost-plus" contract. There is much discussion going on concerning these types of contract and many members of Congress are persuaded that either the one or the other kind is fundamentally wrong. It will be recalled that during the war a modified form of cost-plus contract was used by the Construction Division of the Army, which form was absolutely essential to the emergency work that was required. This form of contract has engendered much opposition and yet there are persons who advocate that it be adopted throughout all Government construction procedure whether in war or in peace. It is a subject quite unfamiliar to the legislator who has not given much study to it and there is always the danger that by riders to appropriation bills which go through in a hurry and without mature consideration, the construction work of the Government may be seriously hampered as it already has been in some instances in the Construction Division. Long before the war, there was need for reform, especially in the river and harbor work and that of the Reclamation Service. Under the lump sum process in vogue too many contractors failed, with the result that great losses were involved, not only on the part of the contractors, but also on the part of the Government. This subject, with especial reference to the cost-plus contract, has already been studied officially by one member of Council, who as chairman of a committee, during the early part of the war, rendered a report in favor of the cost-plus principle followed by the Construction Division. This is unquestionably a matter of great importance, and should receive thorough consideration by a qualified committee, and ultimately be made a subject of legislation.

Relations of Engineering Council to National, State and Local Societies

At the last session of the Chicago Conference, the chairman announced an opportunity for frank discussion of society relations which it was hoped would bring all engineers into harmony. The chairman of Engineering Council gave facts concerning Council and the methods and limitations under which engineering societies could become members. The discussion which followed gave clear indication that it was the desire of the delegates that some closer relation should be achieved. The remarks of W. H. Hoyt, delegate from the Minnesota Joint Engineering Board, conveyed the sentiments of those present as well as those of many others:

Engineering Council has done wonderful work in the few years it has been organized. They have shown to my mind simply the pos-

[1] Washington Office in charge of M. O. Leighton, *Chairman*, National Service Committee, McLachlen Building, 10th and G Streets.

sibilities. They have merely opened up the field. The appointment of their committees alone shows the enormous work that is to be done and can be done, but I believe, gentlemen, that it will not be a success until that Council is organized in some way so that it may feel the effect directly from the individual member at home, just exactly in the same way that your representative sits up and takes notice when he gets a letter from home—that represents personal and local interest. How that can be brought about, I don't know. It will be developed; there is no question about that. The men that are at the head of this question now are men capable of producing those results, and I can see it coming. As Mr. Channing has said, the question now is a live one. In my opinion, Council cannot be a success until it has a broader form of government, more personal backing and support from the individual societies throughout the country which give it its life and also the general support and backing which it will be able to obtain when they have such control over such an organization. In regard to financial backing, I believe there will be no question at all of obtaining all the finances necessary if it has the organization, shows the disposition and has the direct and immediate initiative to take hold of that work and the will to do it.

The National Budget

A national budget system, which engineers have long regarded as essential to the proper conduct of our fiscal affairs, is at last being seriously considered by Congress and seems likely to be adopted in some form. Several bills and joint resolutions have already been introduced but the measure which seems to attract the most attention is that introduced by Representative Good, Chairman of the House Committee on Appropriations. The origin of the bill is not without its significance because some of the strongest opposition to a budget system that has heretofore been developed in Congress has come from the members of this important committee.

The Good bill provides for the creation of a Bureau of the Budget in the office of the President, to which full information shall be furnished by all Departments and other Governmental agencies concerning powers, duties, financial transactions, business methods, etc. This Bureau is authorized to make investigation of all provisions of law dealing in any way with the preparation and transmission to Congress of estimates and other financial data, in order to determine what changes should be made, to the end that all the requirements shall be brought in harmony with an alternative budget which the President is authorized to submit to Congress. The President is further authorized to submit his recommendations as to how the needs of the Government should be met, and such further data regarding the financial affairs of the Government as he deems proper.

The bill abolishes the offices of Comptroller of the Treasury and all the Auditors for the several Departments, and substitutes therefor an Accounting Department, an establishment independent of the Executive Departments, under the direction of a newly created officer to be known as the "Comptroller General of the United States" whose powers shall comprise all those now conferred on the Comptroller of the Treasury and the several Auditors and, in addition, the investigation of all matters relating to the receipt or disbursement of public funds.

There is also created a joint committee of Congress to be known as "Joint Committee on Receipts and Expenditures of the Government," to consist of three members each of the Senate and House of Representatives, which committee shall investigate methods and procedure relating to the receipts and expenditures of the Government; recommend changes in laws and regulations, and accompany its recommendations by bill embodying same.

Engineering Research

The movement for Federal endowment of engineering and industrial research was revived early in the present Congress by the introduction of two bills into the Senate. The first, introduced by Senator Smith of Georgia, provides for the establishment of an engineering experiment station in each state, under the direction of and in connection with some university, engineering school, or land-grant college. The state legislature of each state is authorized to designate the institution best equipped to conduct the work but wherever the land-grant college has facilities approximately equal to those of the other institutions of the state, it shall be designated. All designations of institutions are made subject to the approval of the Secretary of Commerce.

The sums of $30,000, $40,000 and $50,000 for the first, second and third fiscal years respectively, and thereafter $50,000 annually, are appropriated to each state which by acts of its legislature assents to the provisions of this act. The Secretary of Commerce is authorized to secure practical uniformity of methods by indicating such lines of work as shall be of importance from a military, naval, industrial or national standpoint, but responsibility for the conduct of the research shall rest with the individual experiment stations. Uniform standards of research are further provided for by making each experiment station a depository of the Department of Commerce and the Bureau of Standards, and the work of each station shall conform to the standards established by the U. S. Government.

The practical difficulty with the Smith bill is that it leaves open the question which has heretofore made it impossible to unite on any bill, namely, that the selection of the institution to receive the endowment is open to debate, and it will in too many cases depend on the influence each one may be able to muster in a state legislature. It opens up again the old contest between the state universities and the land-grant colleges by providing that the latter shall be selected if their facilities for conducting the work are equivalent to those of other institutions of the state. This again is a question leading to endless debate.

The second or Gronna bill sets up the Secretary of Commerce and the National Research Council as a "National Board on Engineering and Industrial Research" which shall appoint in each state and territory a state research board to consist of five engineers or scientists which shall have immediate supervision over the conduct of engineering and industrial research. Each state board shall utilize such laboratories, equipment and individuals as may be available in connection with any institution of learning within the state or territory, but before authorizing any investigations report shall be made to the Secretary of Commerce and authority to proceed shall be secured from the national board. The sum of $15,000 per annum is provided for expenditure in each state for the purposes aforesaid.

No statement can yet be made as to probabilities, but it is to be hoped that, in consideration of the matter that will soon take place, some opportunity will be afforded to present the real merits.

War Minerals Relief Commission

In MECHANICAL ENGINEERING for May (p. 489) announcement was made of the appointment of a commission to review the claims of producers of manganese, chrome, pyrites and tungsten, who in their efforts to meet Government requirements during the war met with heavy losses. One thousand two hundred and eighty-seven claims with a total of over $18,000,000, were filed with the Commission prior to midnight, June 2, when the Act specified that the docket closed. An investigation, however, shows that a large number of the claims are subject to a material reduction, and the Commission believes that this reduction will permit the payment of all claims out of the $8,000,000, which was made available for this purpose.

The Commission is now making up a tour of mining centers at which hearings have been scheduled, and it is believed that the conduct of these hearings will require about three months. The Commission contemplates numerous difficult problems in administering the law. The most important, perhaps, is the interpretation of the "request or demand" of a Government agency which induced the claimant to undertake his venture. Important claims from various parts of the country and from the producers of different metals will be heard before the Commission makes its interpretation of this feature of the law. Since it is generally understood that this legislation was for the purpose of discharging moral obligations on the part of the Government, it is anticipated that the Commission will admit all claims in which it is shown that the claimant was responding to the general Government policy of stimulation.

NEWS OF THE ENGINEERING SOCIETIES

Reports of Meetings of Taylor Society, Heating and Ventilating Engineers, National Electric Light Association, Iron and Steel Institute, Engineering Society of Western Massachusetts, etc.

Taylor Society

IT was decided at a recent meeting of the Taylor Society to intensify and extend its activities, particularly along the following lines: The restoration of a recognized center of information and advice concerning scientific management; the classification and recording of data concerning the application of the principles of scientific management; the coördination of experiments and investigations; the publication of bulletins of standard practice and general pertinent information; the organization of machinery for lectures before industrial associations and educational institutions on the science and art of management; coöperation with educational institutions in determining the best methods of instruction in scientific management and in preparing material therefor; efforts to enlist the sympathy and coöperation of labor in the discovery and application of the best principles of management; and the development of a code of ethics to govern the practice of the consulting engineer in management and the administrator in both private and public service.

Provisions in the constitution were adopted to promote the increase of membership so as to include all who are seriously interested in scientific management. The affairs of the society have been placed in charge of Dr. H. S. Person who was elected Managing Director. The temporary New York headquarters of the society are in the Engineering Societies Building in space loaned by The American Society of Mechanical Engineers.

National Fire Protection Association

To promote the continued observance by the people of the United States and of Canada, both privately and in their occupations, of the measures for conservation of our natural resources adopted for the war emergency, was the import of the general resolutions adopted by the National Fire Protection Association at their twenty-third annual meeting in Ottawa, Ontario, May 6 to 8.

In its warfare against the needless sacrifice of human lives and property by fire, the association advocated the enactment of ordinances placing upon citizens who disregard fire-prevention orders the cost of extinguishing preventable fires, and a more general legal recognition of the common-law principle of personal liability for damage resulting from fires due to carelessness or neglect. Other measures recommended included the adoption by municipalities of the Standard Building Code of the National Board of Fire Underwriters; a wider general use of the automatic sprinkler as a fire-extinguishing agent, of the fire-division wall and of the life-saving exit facility; and the exclusive use of slow-burning motion-picture films, with national, provincial, state and local legislation to prevent the continued manufacture and distribution of material having the hazardous properties of the gun-cotton stock now commonly employed.

American Association of Engineers

Civic, social and legal problems affecting engineers were discussed at the fifth annual convention of the American Association of Engineers in Chicago, May 12 and 13. Of special importance was the report of the Compensation Committee of the Chicago Chapter, which contained detailed salary schedules submitted by the chapter to the national body with the suggestion that they utilize the data presented in a nation-wide and comprehensive study and seek to formulate a comprehensive schedule. This recommendation was approved by the convention, and the association is preparing to proceed with the work.

Changes made in the constitution were as follows: Junior members are given the right to vote; a new grade of membership called "candidate junior" is provided which requires but one year's education in a recognized technical college or one year of practical experience; a national practice committee is authorized, to report on questions of ethical policy and conduct; the latest past-president is to be a director; the board is authorized to make mutual agreements with other societies.

Dr. F. H. Newell, head of the department of civil engineering, College of Engineering, University of Illinois, was elected president of the association for the term 1919-1920. Dr. Newell is a member of the American Society of Civil Engineers, The American Society of Mechanical Engineers and the Western Society of Engineers, and is one of the original members of the Engineering Council.

Society of Heating and Ventilating Engineers

Among the various interesting committee reports presented at the semi-annual meeting of the American Society of Heating and Ventilating Engineers, held in Pittsburg, June 10 to 12, that of the Committee to Cooperate with the U. S. Navy Department is worthy of special mention on account of the researches undertaken by the committee in connection with the heating, ventilating and humidifying of battleships and submarines. The present system of heating submarines is by electricity. There are usually six electric heating units of two sizes, one taking 15 amperes and the other 25 amperes with a voltage varying from 110 to 115. These units draw energy from a storage battery. The committee, after investigating the characteristics of other systems of heating, such as combustion of smokeless powder, combustion of hydrogen and oxygen, combustion of acetylene and oxygen, and storage of heat in water and steam, have reached the conclusion that the system of heating by storage of heat in water can be advantageously substituted for the storage battery. They argue that a boiler of suitable capacity, capable of withstanding a pressure of about 300 lb. abs. per sq. in. could be installed in such a manner as to utilize the heat of the gases discharged by the engines when these are in operation. Such a boiler, containing about 3153 lb. of water, would store, they claim, about 1,135,000 B.t.u. which is equivalent to the number of heat units given out in 24 hours by the six electric heaters usually installed in a submarine boat. With an assumed total weight of 6000 lb. for the boiler and the water there would be a saving of 92.5 per cent of the weight required by a storage-battery equipment of equal heat-carrying capacity.

Some of the professional papers presented were: Classroom Ventilation, by Konrad Meier; Heating and Ventilating the Standard School House, by J. D. Cassell; Utilization of Sprinkler-System Piping for Heating, by A. W. Moulder; Heating and Ventilating Systems at the United States Government's Smokeless Powder Plant, at Nitro, W. Va., by G. W. Hubbard; Capacities of Reducing Valves for Steam-Heating Systems, by James A. Donnelly; and Cracking of Cast-Iron Sectional Hot-Water Boilers, by C. R. Honiball.

National Electric Light Association

The National Electric Light Association held its annual convention at Atlantic City, N. J., during the week beginning May 19. Municipal ownership, conservation of power resources and lamp production were the subjects discussed at the general sessions, the questions of prime movers, oil switches, underground construction and overhead lines being taken up at the technical sessions.

George Otis Smith, Director of the United States Geological

Survey, called attention to the difference in man power required by a steam plant and a hydroelectric plant, and cited the case of the Alabama Power Company, where the ratio was 84 to 1. The report of the lamp committee showed the total sales of incandescent lamps for domestic purposes, excluding miniatures, during 1918, to be 186,000,000, of which nearly 90 per cent were tungsten-filament lamps and the remainder carbon and "gem." The production of gem lamps, it was stated, has now been discontinued.

The committee on prime movers discussed in their report various phases of the problem of selecting turbines with proper regard to the size of the system as a whole, and included information as to the operating records of large-sized turbines, together with statements submitted by manufacturers reviewing progress during the past year. The development of power-station auxiliaries was treated at length and a wider use of boiler- and turbine-room instruments was recommended. Improvements in general design of hydroelectric installations were enumerated and the record of progress was noted.

The report of the committee on electrical apparatus covered particularly the control of fires in generators, some special phases of switchboard and transformer practice, substations with special reference to outdoor substations and automatic substations, power-factor correction, and apparatus for special fields, including electric furnaces, welding and the mining field.

In reference to underground distribution, the committee on this subject reported that a marked change had occurred in the load curve of central-station companies due to their taking on large blocks of load to serve industries working on a 24-hour basis. The result of thus obliging all classes of equipment to operate at a higher load factor than before, the committee asserted, has been an unusually large number of cable failures, with the resulting necessity for careful attention to the matter of rating cable capacities.

American Iron and Steel Institute

Optimism over the outlook in the iron and steel trades was expressed by Judge Elbert H. Gary in his opening address at the fifteenth general meeting of the American Iron and Steel Institute, held in New York on May 23.

Following Judge Gary's address several papers of technical interest were read. In a paper entitled Electrically-Heated Soaking Pits and Heating Furnaces, T. F. Baily, president of the Electric Furnace Co., Alliance, Ohio, considered the electric soaking pit for hot ingots as perhaps the most promising development of the electric furnace to the steel maker. Admitting that under ordinary circumstances when heating cold ingots electric pits could not compete in fuel economy with fuel-fired pits, he observed, however, that in the larger mills, when running at full capacity, features such as lack of uniformity in temperature of the heated ingot, excessive oxidation of the ingot and the like were often such as to quite outweigh the item of mere fuel. He said that the time was not far distant when substantially all modern mills rolling hot ingots would use electric pits for this part of steel-mill operation.

In a paper on the Present Status of Non-Metallic Impurities in Steel, Henry D. Hibbard, consulting engineer, Plainfield, N. J., discussed the occurrence and composition of solid non-metallic impurities or "sonims," and made reference to the experimental research so far completed by the committee on the elimination of sonims in steel instituted by the National Research Council, of which he is the chairman. In order to make steel as clean of sonims as practicable, the following rules were recommended:

1 Have the unfinished steel as free from oxides as possible at the end to diminish the work for the final additions to do and the quantity of sonims to be made by holding it without ore additions and with ample carbon and manganese in the bath. The manner and rate of boiling and the fracture of a slag sample will tell the furnaceman how his bath is in this respect. The "boil" must not be vigorous for the percentage of carbon in the metal.

2 Time must be allowed to elapse after the addition of the manganese for the sonims to be precipitated, or changed chemically as already noted, then to collect into globules or drops, and then to float to the top. Probably moderate agitation or stirring helps materially this gathering of sonims into drops of floatable size.

Other notable papers of technical interest were: Methods of Charging Raw Materials into the Blast Furnace, by J. A. Mohr, Superintendent, Currie Blast Furnaces, Carnegie Steel Co., Rankin, Pa.; Standardization of Shipbuilding Materials, by F. T. Llewellyn, Federal Shipbuilding Co., Kearney, N. J., and Chickasaw Shipbuilding Co., Mobile, Ala.; and Notes on Open-Hearth Practice, by H. M. Howe, professor emeritus, Columbia University, Bedford Hills, N. Y.

International Railway Fuel Association

Aspects of the fuel-conservation problem, both from the mechanical and operating standpoints, were extensively discussed at the eleventh annual meeting of the International Railway Fuel Association, which convened on May 19 in Chicago.

President L. R. Pyle drew a pertinent comparison between the service given by the railroads during the war and that which would be expected of them during the reconstruction period. To offset the increase in the cost of operation, he said, it is necessary to eliminate waste wherever it appears. All should bear in mind that practically everything done to save coal has a beneficial effect on all other angles of railroad operation.

The Committee on Pulverized Fuel reported that five American railroads—the Atchison, Topeka & Santa Fe, Chicago & Northwestern, Delaware & Hudson, Missouri, Kansas & Texas, and New York Central—have successfully operated during test periods individual locomotives equipped for and burning pulverized coal. The report quotes from some of the answers received by the committee to their request for information on results obtained from the tests made on locomotives. The following are notable instances:

a A carefully conducted test between two engines of the same class, one burning pulverized coal and the other hand-fired, showed that a saving of 23 per cent in fuel burned could be made by burning pulverized coal. The main difficulties encountered were the slagging over of the flue sheet and burning out of the brick arch. The former was largely overcome by an air jet to blow off the slag accumulations. A number of burner arrangements were tried, but it was found impossible to overcome the rapid burning out of the brick arch and the cost of replacing the arch brick practically equaled the saving in fuel. The delay to locomotives in replacing arch brick was also a decided drawback.

A comparison of total costs of hand firing versus pulverized-coal firing on the locomotives tested, which included cost of pulverizing, cost of handling, cost of arch manufacture, interest and depreciation, showed the hand firing to be most economical. In fairness to the pulverized coal, however, it was thought possible to design a firebox that would eliminate such troubles as burning out of the brick arch and show an advantage in favor of the pulverized coal.

b Burning pulverized fuel was very satisfactory; had all the steam that was wanted with splendid control all the time, burning 60 per cent anthracite and 40 per cent bituminous, the bituminous being necessary to increase the volatile. The question of economy is quite another thing and unless a poor or by-product coal can be purchased at a price that will absorb carrying charges, operation, etc., of a pulverizing plant and not exceed the price of a satisfactory lump coal, it should be given careful thought. There is no saving in the quantity of fuel used when pulverized, in fact, the difference is in favor of the lump coal. Pulverizing costs between 45 cents and 50 cents per ton.

From these and other answers received from pulverized-fuel installations operating on stationary engines, the Committee concluded that "the experimental work done and tests made, although still incomplete, have demonstrated the apparent soundness of the principle of burning coal in a finely divided form of suspension," but that "there are some things about pulverized coal" the Committee "are not satisfied with." They observe, for instance, that "it has not been clearly established that coal ground to the extreme fineness and dried to the extent recommended by most of the supporters of pulverized coal best meets the conditions of the practical user operating under widely diversified conditions," and that "the tendency of explosion and spontaneous combustion" has not been eliminated entirely.

Engineering Society of Western Massachusetts Organizes

The organization meeting of the newly formed Engineering Society of Western Massachusetts was held at Hotel Kimball, Springfield, on the evening of April 16. It was preceded by a dinner at which over 300 engineers representative of the various branches of the profession were present.

After dinner the meeting was called to order by George E. Williamson of the organization committee who briefly recited the history of the movement. The constitution and by-laws proposed and drawn up by the organization committee were then unanimously adopted as written and the following officers and directors unanimously elected:

President: Charles L. Newcomb, Manager, Am.Soc.M.E., Manager Deane Works, Worthington Pump and Machinery Corporation, Holyoke.

Vice-Presidents: C. C. Chesney, Fellow A. I. E. E., Manager General Electric Pittsfield Works; and George E. Williamson, Mem.Am.Soc.M.E., Chief Engineer, Strathmore Paper Co., Woronoco.

Secretary-Treasurer: Winfield E. Holmes, Mem.Am.Soc.M.E., Treasurer, Samuel M. Green Co., Springfield.

Directors: Dr. Herbert C. Emerson, Mem. Am. Chem. Soc., Springfield; Frank O. Wells, Manager Am.Soc.M.E., Greenfield; John C. Robinson, Springfield; E. E. Lochridge, Mem. Am. Soc. C. E., Springfield; Samuel M. Green, Mem.Am.Soc. M.E., Springfield; Geo. P. B. Alderman, Holyoke.

The meeting was then turned over to President Newcomb, who, in acknowledging the honor that had been conferred upon him, assured the society of his best efforts in the office to which he had been elected, and made a short address on the object and scope of the new organization, predicting for it an important and growing sphere in the community and the engineering world. It would have a purely engineering character, he said, but would embrace engineers of all branches. The American Society of Mechanical Engineers had thought well enough of the movement to have its Sections Committee present, and President Cooley would have attended but was unavoidably detained. Secretary Rice had also telegraphed from Denver expressing his regret at being unable to carry out his intentions of being present, and conveying his compliments to the new society. It was hoped to soon receive like recognition from all the national engineering societies.

Prof. L. P. Breckinridge of Yale University, who was then introduced, complimented the society upon its efforts to bring the various branches of engineering into one local organization, predicting that in the future the national organizations would get together in a great engineering body, and that it would then be pointed out that western Massachusetts had done the same thing in 1919.

William Spencer Murray, consulting engineer of New York, and who electrified the New Haven Railroad and the Hoosac Tunnel, spoke upon conservation and described a project he had been developing for the Secretary of the Interior which involved large-scale development of hydroelectric power and electric power at the pit mouth and the installation of a super-power distributing line from Washington to Boston. Mr. Murray submitted data upon the enormous consequent saving in coal and reduction of power cost in the region served by the proposed super-power line, and showed the gathering of engineers the entire feasibility of Secretary Lane's plan.

Dr. George Otis Smith, director of United States Geological Survey, followed Mr. Murray and furnished valuable data relating to the proposed super-power line, amplifying, substantiating, and further explaining his statements.

The meeting then adjourned with many additional applications for membership.

The objects of the society as stated in the constitution are—"The professional improvement of its members; the advancement of the arts and sciences connected with the various branches of engineering; the promotion of civic righteousness and truth and the participation in affairs of an engineering nature which affect the interest of the public." Headquarters will be in Springfield and regular meetings will be held in the various cities and communities of western Massachusetts.

The early history of the Engineering Society of Western Massachusetts really dates back to some two or three years ago, when it was proposed to organize a local section of The American Society of Mechanical Engineers in Springfield and vicinity. The matter was taken up again this year when Calvin W. Rice, Secretary of the A. S. M. E., and William G. Starkweather, Chairman of its Boston Section, conferred at the Hotel Kimball with Messrs. George E. Williamson, William J. A. London, C. W. Burges, and Winfield E. Holmes. After thoroughly canvassing the local situation Mr. Rice suggested that a regional engineering society be formed that would appeal to and embrace not only mechanical engineers but engineers of all branches.

This preliminary committee of four met again the following week and each was in agreement that the new engineering society

C. L. NEWCOMB
President

C. C. CHESNEY
Vice-President

G. E. WILLIAMSON
Vice-President

W. E. HOLMES
Secretary-Treasurer

OFFICERS OF THE ENGINEERING SOCIETY OF WESTERN MASSACHUSETTS

should be inaugurated. Thereupon twenty other local engineers, architects, and chemists, were asked to participate in a conference on the subject, which was done January 21, 1919. At a later meeting, on February 17, the organization committee completed much of its preliminary work and made arrangements for the initial meeting on April 16.

Colorado Engineering Council

At a specially arranged meeting of the Colorado sections of the founder engineering societies and other local scientific organizations, held at Denver on May 16, the final form of the constitution of an association to be known as the Colorado Engineering Council was discussed and adopted. The purpose of this council is to coördinate the work of various technical, scientific and engineering organizations, to promote the welfare and professional standing of their members, and to foster a more general recognition of the engineer in civic matters. All local scientific associations are eligible for membership in the Council.

PROPOSED REORGANIZATION OF THE AMERICAN ENGINEERING STANDARDS COMMITTEE

AT the present time many bodies are engaged in the formulation of standards. There is no uniformity in the rules for such procedure in the different organizations; in some cases the committees engaged in the work are not fully representative, and in a considerable proportion of cases they do not consult all the allied interests. The present custom results in a considerable duplication of work, and there are in some fields several "standards" proposed for the same thing that differ from each other only slightly and that often in unimportant details. It is very much more difficult to obtain agreement between proposers of overlapping standards after they have been published than it would be to get the proposers to agree before they had committed themselves publicly.

The American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, appointed a committee to consider the advisability of coöperating in engineering standardization, upon whose recommendation the American Engineering Standards Committee was formed, with a membership consisting of representatives of the five societies mentioned.

The American Engineering Standards Committee has held a series of meetings for the purpose of revising the constitution, and the following communication containing the proposed constitution is being sent to members of the Council of The American Society of Mechanical Engineers and to the governing boards of the other Founder Societies which were instrumental in organizing the American Engineering Standards Committee.

TO THE COUNCIL OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Gentlemen:

At a regularly called meeting of the American Engineering Standards Committee held on May 17, 1919, a proposed revision of its constitution was approved by the committee. In submitting this revised constitution to your board for its approval, we desire to give the reasons and to offer some explanations for the proposed changes in the present constitution of this committee.

Soon after its formal organization on October 19, 1918, the committee began its work under the present constitution. But it became evident immediately that some organizations and societies were not willing to coöperate under the existing form of organization. This feeling was also expressed very freely and positively at a conference held in Washington on January 15, 1919. On this date representatives of more than one hundred organizations, including federal, state and municipal boards, who are interested, in the formulation of safety codes, met to consider how they might coöperate to develop these codes in an efficient and generally satisfactory manner. The objects of the five societies in organizing the American Engineering Standards Committee and the committee's method of procedure were very fully and carefully presented to this conference. The discussion which followed, however, indicated a feeling, especially among some large national organizations which have for some years been developing safety codes, that the present method of selecting representatives to this committee is not broad enough to permit them to coöperate completely.

Following this Washington conference a number of meetings and conferences between the American Engineering Standards Committee and other organizations interested in the development of standards were held. These meetings have convinced this committee that, if its work is to receive nation-wide, general, and immediate acceptance, some changes in its constitution are necessary.

The most important of these is contained in Sections 8 and 9. They state that the proposed Association starting with a membership consisting of representatives of the five Founder Societies and Government Departments may add representatives from other organizations or groups of organizations. To permit this enlarged committee or association to function easily, Article V provides for a Board of Directors of twelve members of the Association.

It should be stated here, however, that the objects for which the committee was originally organized, though restated in the proposed new constitution, are exactly the same. We desire especially to call your attention to Section 4. This is a definite declaration of the Association's policy of non-interference with the absolute autonomy of any group engaged in the development of a standard. The failure to recognize this is responsible for much of the misunderstanding and fear of interference that has found expression in the technical press, and even by well-meaning, but misinformed members of already affiliated organizations.

Article VII on the "Development and Approval of Standards" now states in no uncertain terms what has always been the intent of those instrumental in the organization of the Committee, viz., it will be entirely optional on the part of the organizations having representation on the new Association, to submit their existing standards and those developed in the future for the approval of the American Engineering Standards Association. But it is hoped that as the Association develops and its policies become well understood, the advantages of this approval will become so apparent that all societies and organizations producing standards will desire to submit their standards for approval. This article of the revised constitution further provides that full credit and recognition for its work in producing a standard will be given to the sponsor society or organization producing it, and the standard will be known by the name assigned to it by the sponsor society.

Trusting that you will consider carefully, and finally approve these proposed changes in our Constitution, we remain

Very respectfully,
AMERICAN ENGINEERING STANDARDS COMMITTEE,
GEORGE C. STONE,
Vice-Chairman.

PROPOSED CHANGES IN THE CONSTITUTION OF THE AMERICAN ENGINEERING STANDARDS COMMITTEE

The Constitution of the American Engineering Standards Committee shall be changed to read as follows:

ARTICLE I. NAME

Sec. 1. The name of this association shall be the American Engineering Standards Association, hereinafter referred to as the Association.

ARTICLE II. OBJECTS

The objects of the Association shall be:

Sec. 2. To unify and simplify the methods of arriving at engineering standards, to secure coöperation between various organizations, and to prevent duplication of standardization work;

Sec. 3. To promulgate rules for the development and approval of standards;

Sec. 4. To receive and pass upon recommendations for standards submitted as provided in the Rules of Procedure, but not to initiate, define, nor develop the details of any particular standard;

Sec. 5. To act as a means of intercommunication between organizations and individuals interested in the problems of standardization;

Sec. 6. To give an international status to American engineering standards.

Sec. 7. To coöperate with similar organizations in other countries and to promote international standardization.

ARTICLE III. MEMBERSHIP

Sec. 8. The Association shall be composed of not more than three representatives from the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society for Testing Materials, the Government Departments of War, Navy, and Commerce, and from each of such other organizations or groups of organizations as may be approved as hereinafter provided. The vote of the Association shall lie with these representatives, who shall be termed members. Each member shall have one vote.

Sec. 9. The Association may, upon a majority vote, invite any organization or group of organizations to join in its work. This vote of the Association shall be by letter ballot.

Sec. 10. Any organization or group of organizations desiring representation in the Association shall make formal application therefor in writing, setting forth the scope of its standardization interests and activities and the number of its members. This application shall be considered at the next regular meeting of the Board of Directors and, upon a majority vote, shall be submitted to the Association. The Association shall vote on the application by letter ballot which shall be drawn upon the recommendations of the Board of Directors and shall state whether one, two, or three representatives are recommended. Upon a majority vote of the Association the organization or group of organizations making application shall be requested to appoint representatives not exceeding the specified number, who shall become members of the Association after properly qualifying.

Sec. 11. The number of representatives any organization or group of organizations is requested to appoint shall be determined by such considerations as: the volume, character, and importance of its standardization work, if any, together with its standing and total membership.

Sec. 12. Any organization or group of organizations appointing representatives to the Association shall agree to assume the financial obligations herein set forth and to abide by the Constitution, By-Laws, and Rules of the Association. In the case of members appointed by the Government, State or Municipal departments or bureaus, it is

understood that financial support is not expected until such time as proper authorization therefor can be obtained.

Sec. 13. Initially, each organization or group of organizations shall appoint its first representative to serve three years, the second to serve two years, and the third to serve one year. After the first year all appointments shall be for three years.

Sec. 14. A member whose term of office has expired may be reappointed. A vacancy shall be filled by the organization or group of organizations from which the retiring member was originally appointed, such appointment to be for the unexpired term.

Sec. 15. Any member may resign from the Association upon written notification to the Secretary. Any organization or group of organizations may withdraw its representatives from the Association upon notice in writing to the Secretary, provided the dues for the current calendar half-year have been paid.

Sec. 16. Any organization or group of organizations in arrears for dues for more than one year will thereby lose its right to representation in the Association.

ARTICLE IV. OFFICERS

Sec. 17. At its Annual Meeting the Association shall elect a Chairman and Vice-Chairman from its membership. Officers so elected shall serve for one year, or until their successors are elected. These officers shall not serve for more than three consecutive terms. Vacancies may be filled by election at any regular or special meeting, provided notice has been given in the call for the meeting.

Sec. 18. A Secretary shall be engaged by the Board of Directors.

Sec. 19. The Chairman shall be the executive officer of the Association, shall approve all expenditures and countersign all vouchers. He shall preside at all meetings of the Association. He shall be ex-officio member of all committees and Chairman of the Board of Directors. In the absence of the Chairman his duties shall be taken over by the Vice-Chairman, and in the absence of both, by a member of the Board of Directors.

Sec. 20. The Secretary shall perform all duties usual to the office of a secretary, shall maintain a file of information on and in connection with standards, a list of organizations interested in standardization work, and such other information as may be necessary for the work of the Association. He shall have sufficient authority to conduct the routine business of the Association under such instructions as may be from time to time given him by the Board of Directors.

ARTICLE V. BOARD OF DIRECTORS

Sec. 21. The affairs of the Association shall be managed by a Board of Directors elected from the membership of the Association at its Annual Meeting.

Sec. 22. The Board shall consist of not more than twelve members, and shall not include more than one representative from any one organization or group of organizations.

Sec. 23. The Board shall be the legal trustee of the property of the Association and shall have power to deal with all affairs of the Association except that of approving "Recommended Practices," "Tentative Standards" or "Standards of the American Engineering Standards Association."

Sec. 24. The Board may, by resolution, delegate any of its powers to committees or to any one or more of its members, but no act of such committee or delegates shall be binding upon the Association until it has been approved by the Board.

Sec. 25. All suggestions, inquiries, or complaints as to the purposes, objects, or methods of this Association shall be referred to and answered as directed by the Board of Directors.

Sec. 26. The Board shall submit a report at the Annual Meeting describing the work done in the past fiscal year and showing the financial condition of the Association. An abstract of this report shall be entered in the minutes of the meeting.

Sec. 27. A quorum of the Board of Directors shall be a majority of its membership.

ARTICLE VI. MEETINGS

Sec. 28. The Association shall hold the Annual Meeting in the month of November. It may hold additional meetings at any time either at the call of the Chairman or upon written request of not less than ten members. The call for a meeting shall be mailed to each member of the Association at least ten days before the date set for the meeting.

Sec. 29. A quorum of the Association shall consist of a majority of its members.

ARTICLE VII. DEVELOPMENT AND APPROVAL OF STANDARDS

Sec. 30. The Association shall formulate rules under which committees to create standards shall be constituted and organized.

Sec. 31. The Association shall receive and pass upon recommendations for standards which may be submitted by any competent body.

Sec. 32. Any proposed standard approved by the Association shall be known as a "Recommended Practice of the American Engineering Standards Association," or as a "Tentative Standard of the American Engineering Standards Association," and when in the opinion of this Association it has proved its suitability, it shall be known as a "Standard of the American Engineering Standards Association." In every case publication shall bear the title assigned to the standard by the Sponsor organization and the name of the Sponsor followed by the statement: "Approved as Recommended Practice, Tentative Standard, or Standard of the American Engineering Standards Association."

Sec. 33. The approval as "Recommended Practice" or as "Tentative Standard" of any standard submitted to the Association shall require the affirmative vote of three-fourths of the Association; the advance of status to "Standard" shall require an affirmative vote of 90 per cent. of the Association. Such votes shall be by letter ballot. Letter ballots may be ordered at any regular or special meeting of the Association, or at any meeting of the Board of Directors.

ARTICLE VIII. FINANCES

Sec. 34. Each organization appointing representatives to the Association shall pay annual dues of $500.00 for each representative. These dues shall be paid semi-annually.

Sec. 35. Other funds may be obtained in any manner approved by the Association.

Sec. 36. Funds of the Association shall be in the custody of the Secretary, who shall be placed under suitable bond, and they shall be disbursed by him upon vouchers countersigned by the Chairman or Vice-Chairman.

Sec. 37. The fiscal year of the Association shall terminate with the 31st day of December.

ARTICLE IX. AMENDMENTS

Sec. 38. Amendments to this Constitution must be proposed in writing at least thirty days before the meeting of the Association at which they are to be voted upon, this vote to be upon the amendment as originally proposed or as further amended at the meeting. If passed by a two-thirds majority of those present they shall be referred to the Governing Boards of all the organizations or groups of organizations represented in the Association, and shall become operative only when they have been approved by the organizations or groups of organizations appointing at least two-thirds of the membership of the Association.

HONORARY MEMBER OF A. S. M. E. RECEIVES JOHN FRITZ MEDAL

MAJOR-GENERAL GEORGE W. GOETHALS, upon whom was conferred Honorary Membership by The American Society of Mechanical Engineers at its 1917 Annual Meeting, was accorded on the evening of May 22 the further distinction of receiving the John Fritz Medal for his achievements in building the Panama Canal. The exercises were held in the auditorium of the Engineering Societies Building, New York City, Charles F. Rand, past-president of the American Institute of Mining and Metallurgical Engineers and Secretary of the Board of Award, presiding in the absence of Clemens Herschel, past-president of the American Society of Civil Engineers, Chairman of the Board. As is well known, this medal was established in 1902 in honor of the great American engineer, John Fritz, who was also the first recipient of the medal. A board representing the four national engineering societies—the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers—awards the medal not oftener than once a year for notable achievement along engineering lines. Other distinguished recipients of the John Fritz Medal have been: Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Charles T. Porter, Alfred Noble, Sir William H. White, Robert W. Hunt, John E. Sweet, James Douglas, Elihu Thomson, Henry M. Howe and J. Waldo Smith.

A fitting tribute was paid by William L. Saunders, past-president of the American Institute of Mining and Metallurgical Engineers, to the perseverance, skill, tenacious application and devotion to duty by which General Goethals brought to a successful termination the building of one of the greatest engineering works ever undertaken in history. After briefly reviewing the military career of General Goethals from the time he was appointed second lieutenant at West Point on June 12, 1880, and his later experience as instructor in civil and military engineering in the United States Military Academy, Mr. Saunders concluded with the following impressive remarks:

It has been said that fame comes to a man who is thinking about something else. The chief difference, it seems to me, between common men and big men is in the sense of self-effacement. When a man thinks of himself in his actions in life, he forgets the things that make men great. A thing done for the sake of self-glory or self-profit is only half done; it is only half-baked. It bears the savor of unripe fruit or the taint of decay. A thing to be well done must be well done:

and nothing is done well that does not carry with it the spirit of self-sacrifice in the material or human interests of others.

And so, in giving this token of our esteem tonight to General Goethals, do we honor the man as well as the engineer. We pay this tribute of our admiration and our tears to a great public servant, who, through a long period of inextinguishable devotion to public duty, a period of hard labor, has risen, rung by rung, up the ladder of St. Augustine.

"For the heights by great men reached and kept
Were not attained by sudden flight;
But they, while their companions slept,
Were toiling upward on the night."

Hon. Henry L. Stimson, Secertary of War for a considerable period of time during which the canal was under construction, spoke in part as follows:

The time when I began to have duties in regard to the canal, the period of my service, covered the years 1911 and 1912. At that time the work was in full swing, at its maximum capacity. The long delays and troubles which had marked the beginning had been overcome. The long discussion over the different types of canal, whether it should be a sea-level or a lock canal, had been settled before by the characteristic decision of Mr. Roosevelt. The dreaded scourge of the yellow fever, which had caused many delays in the early years, had been banished forever by the work of Colonel Gorgas and the Medical Corps. The organization of the working forces had been perfected, and the giant machinery was there and in full swing.

Of course, there were many problems meeting the Chief Engineer every day, but, nevertheless, the machine was then working at its fullest capacity; and for that very reason, perhaps, it was possible at that time to see, as at no other time, how the whole work depended and swung upon the character and the force of one man. . . .

By the inexorable necessity of events, there had been an evolution into one man control, and the result of that evolution was Goethals, and the Canal then represented throughout, in every part of its working force, the impress of his personality. The authority which he exercised there was comparable only to the authority of the commander of an expeditionary force in a foreign country; but even that was only a comparison, because he came into contact with his men in a direct, personal way which I have never seen exemplified in the commander of a combatant division.

Ambrose Swasey, past-president of The American Society of Mechanical Engineers, in making the formal presentation of the medal addressed General Goethals and said:

Sir, Major-General George Washington Goethals, Builder of the Panama Canal, we are gathered here to do honor to you, and in so doing we honor ourselves and all those whom we represent.

In a time of peace you went to war with the elements; and with the forces at your command you won for civilization one of the greatest victories of the age.

Whenever your country has called, that high standard of service has been your response—a service you have loyally and faithfully wrought into all your achievements as a soldier; as an engineer; as a man.

On behalf of the Board of Award I have the honor to present to you the John Fritz Medal.

In responding General Goethals paid a tribute to "others who should receive recognition and mention" in connection with the building of the Panama Canal, chief among them being the late Colonel Roosevelt, through whose "persistent efforts . . . the necessary legislation, authorizing the construction of the canal, was due," and who "had the far-sightedness and the courage, after convening an international board of engineers, to repudiate the recommendation of the majority, accept that of the minority and advocate to Congress the construction of a lock canal." General Goethals recalled the work of the doctors "who exhibited the highest type of moral courage when they demonstrated the fact that the mosquito was the transmitter of yellow fever" and who "laid down the principles which ultimately resulted in the eradication of yellow fever from the Canal Zone." He also referred to "the vast number of engineers, employed in this country, who gave the best that was in them in designing the various forms of machinery which were used in the construction work, and, subsequently, machinery employed for the operating of the locks, the lighting of the canal, the handling of our coal, and the operation of our dry-dock"; and to the 50,000 American workmen, every one of whom "was imbued with the idea that the particular part of the work on which he was engaged was absolutely necessary" to the success of the undertaking, and without which the canal would have been a failure.

NECROLOGY

CHARLES MILTON BALDWIN

Charles M. Baldwin, Lieutenant in the United States Navy, died at sea on March 12, 1919. Lieutenant Baldwin was born on March 26, 1876, in Mt. Vernon, Tex., and attended the Southwestern University at Georgetown. He was formerly connected as assistant marine engineer with the Mallory, Red D and Southern Pacific lines. For twelve years, 1903 to 1915, he served in the United States Navy, first as machinist and later as warrant machinist, with a chief engineer's unlimited ocean license. When the United States entered the war he again offered his services and was commissioned a lieutenant in the Navy. He had also served in the Spanish-American War and in the Philippine and Mexican campaigns.

Lieutenant Baldwin was a member of the National Marine Engineers' Beneficial Association, and belonged to a number of fraternal organizations. He became an associate-member of the Society in 1905.

LESTER WARREN COGSWELL

Lester W. Cogswell was born in January, 1880, at Charlestown, Mass. He was educated in the public schools of that city and was graduated from the Mechanics High School.

In 1898 Mr. Cogswell obtained employment in the engineering department of the B. F. Sturtevant Co., Jamaica Plain, Mass., where he served a two-year apprenticeship. Later he was associated with the following firms: the Mason Regulator Co., Dorchester; the Blake Pump Works, East Cambridge; the United Shoe Machinery Co.; the Sub-Target Gun Co.; the Walworth Manufacturing Co.; the Globe Ore Reduction Co., and the United Printing Machine Co., all in Boston.

In the latter part of 1916 Mr. Cogswell became connected with the Kinney Manufacturing Co., also in Boston, where he held the position of designer of engines and rotary pumps. He was with this concern at the time of his death, September 29, 1918.

Mr. Cogswell became an associate-member of the Society in 1917.

WILLIAM W. DINGEE

William W. Dingee was born on January 5, 1831, in Byberry, Pa. He was educated in the Maryland Institute and also attended the School of Mechanical Arts connected with the Institute.

For thirty years Mr. Dingee was the proprietor and superintendent of a foundry and machine business, where he designed, built and operated many machines for general and special purposes. For many years he was associated with the J. I. Case Threshing Co., Racine, Wis., as machine designer and constructor, and while with this concern was the inventor of many improvements for threshing machines.

Mr. Dingee retired from active business in 1906 and the last years of his life were spent in Chicago where he died on May 25, 1919. He was one of the early members of the Society, having joined in 1886.

WALTER ERLENKOTTER

Walter Erlenkotter, vice-president of the Secaw Chemical Co., Irvington, N. J., died on May 14, 1919. Mr. Erlenkotter was born on August 22, 1887, in Hoboken, N. J. He received his early education in the Hoboken Academy and was graduated from Stevens Institute of Technology in 1908. He was formerly connected with J. G. White & Co., New York City, in the design and construction of steam-engineering plants, etc., and later held the position of fuel-engineering chemist in charge of the Central Testing Laboratory, Bureau of Contract Supervision, New York City, where his work dealt with physical tests, sampling, coal analysis, the design of new apparatus, etc. In the latter part of 1916 he became chief engineer for the Secaw Chemical Co. and was subsequently advanced to the position of vice-president. Mr. Erlenkotter became a junior member of the Society in 1912 and in 1916 was promoted to the grade of associate-member.

JAMES J. FLYNN

James J. Flynn was born in April, 1893, in New York City. He was educated in the public schools of the city and was graduated from the Mechanics' Institute. In 1908 he started work for the Western Electric Co., taking their regular students' course and spending six months in their manufacturing department.

He was then transferred to the tool and gage-inspection department where he was located for about five years; he was then placed on construction work of telephone equipment on the road. After

seven years with this concern, Mr. Flynn became associated in 1915 with the Remington Arms Bridgeport Works as assistant low-tension engineer. The following year he was made foreman inspector of the barrel department and in 1918 he became chief inspector of ordnance for the U. S. Government in the same company.

Mr. Flynn became a junior member of the Society in 1918. He died on February 11, 1919.

RICHARD HUMPHREY HUGHES

Richard H. Hughes, vice-president and general manager of the Crescent Portland Cement Co., Wampum, Pa., and a member of the Board of Directors of the Portland Cement Association, died on April 12, 1919.

Mr. Hughes was born on September 16, 1862, in Lima, Ohio. He received his education in the schools of that city and also served there his apprenticeship in railroad engineering. In 1901 he became connected with the Portland Cement Co. and took charge of the remodeling of their plant. During the year 1908 and 1909, in co-operation with Mr. W. B. Ruggles of the Ruggles-Coles Engineering Co., he had entire charge of the designing and building of the company's 3000-barrel plant and upon its completion, of its operation, alteration and additions.

Mr. Hughes belonged to a number of social and fraternal organizations. He became an associate-member of the Society in 1914.

THEODORE H. GUETHING

Theodore H. Guething, Lieutenant in the Ordnance Department of the Army, was born on October 15, 1891, in Winchester, Mass., where he received his early education. He attended Exeter Academy for three years and then entered the Massachusetts Institute of Technology, from which he was graduated in 1915 with the degree of B.S.

THEODORE H. GUETHING

He was connected for short periods with the Haughton Elevator Co., Toledo, Ohio, and with the Anaconda Mining Co., Anaconda, Mont. In June 1916 he became associated with the John A. Stevens Engineering Co., Lowell, Mass., where he was assistant in the analysis of the power plant of the Stevens Manufacturing Co., Fall River, Mass., assistant superintendent of the construction of the power plant for the North & Judd Manufacturing Co., New Britain, Conn., and assistant engineer on motoring, Chelsea Fiber Mills, Brooklyn, N. Y.

When the United States entered the war he offered his services to the Government and was commissioned a first lieutenant in the Ordnance Department of the Army. He was assigned to the Picatinny Arsenal, Dover, N. J., as mechanical engineer in charge of the shops and as motor-transport officer, and was working in this capacity when he contracted influenza-pneumonia and died on October 16, 1918.

Lieutenant Guething became a junior member of the Society in 1917.

ERNEST G. MARBLE

Ernest G. Marble, who, until 1918, was general sales and works manager of the American Engineering Co., Philadelphia, died on May 6, 1919. Mr. Marble was born on September 19, 1876, in Methuen, Mass., and was graduated from Tufts College in 1899. Shortly after he became connected with the Otis Elevator Co. as superintendent of construction of their Philadelphia works, and from 1907 to 1912 was treasurer of the American Ship Windlass Co., with full charge of the manufacturing and financial interests of the concern.

Mr. Marble became associated with the American Engineering Co. in 1912, resigning in the spring of 1918 because of ill health. He became a member of the Society in 1909.

CHARLES W. PRARAY

Charles W. Praray was born on May 29, 1873, in Pawtucket, R. I., and was educated in the public schools of that city. He served an apprenticeship in one of the local cotton mills and for ten years was connected with the B. B. & R. Knight Cotton Manufacturing Co. as master mechanic and engineer. For several years he was master mechanic for the Manomet Mills in New Bedford, Mass., when he became associated with the Holmes Manufacturing Co., also in New Bedford, as superintendent and architect.

About twelve years ago he opened a mill engineer's and architect's office in New Bedford and proved highly successful in his work. He was the designer of some six or seven mills in New Bedford and of a great number of others throughout New England. He was actively connected with this work at the time of his death, March 22, 1919.

Mr. Praray held a first-class Massachusetts engineer's license. He was a member of the National Association of Cotton Manufacturers and of a number of social clubs. He became a member of the Society in 1918.

HENRY S. HAYWARD

Henry S. Hayward, Lieutenant, U. S. Naval Reserve Force, was born on December 25, 1876, in Elizabeth, N. J. He was a 1900 graduate of Stevens Institute of Technology.

HENRY S. HAYWARD

His first position was in the drafting room of the Pennsylvania Railroad, Jersey City, N. J. He was next associated with the Franklin Air Compressor Co., Franklin, Pa., as chief engineer, his work consisting of designing and supervising the construction of their power plant. From 1902 to 1905 he was in business for himself as a mechanical engineer, handling mechanical mill supplies.

In 1906 he became assistant to the vice-president of the Franklin Railway Supply Co., manufacturing and promoting special mechanical devices for locomotives. Prior to his enlistment in 1918 he was president of the Roybel Packing Co., N. Y.

He was commissioned a lieutenant (j.g.) in the Naval Reserve Force and was stationed at the Charleston Navy Yard, Charleston, S. C. He was north on a twenty-day furlough when he contracted pneumonia and died on March 31, 1919.

Lieutenant Hayward became a member of the Society in 1900.

CHARLES JAMES REILLY

Charles James Reilly, Sergeant, Co. C, 21st Engineers, A. E. F., was killed in France, on September 1, 1918, by a bomb dropped from a German airplane, which, according to report, was flying low over the camp and bearing the Allies' colors.

Sergeant Reilly was born on September 10, 1887, in Louisville, Ky. He received his early education in the schools of that city and was graduated from the high school in 1905, when he entered Rose Polytechnic Institute, from which he received his B.S. degree in mechanical engineering in 1909. For three years he was connected with the Louisville & Nashville Railroad in Louisville, Ky., as a machinist in their locomotive-erecting shop. His next position was with the Vandalia Railroad, Terre Haute, Ind., as draftsman in the motive-power department, where he remained for a little over three years, resigning to become connected with the U. S. Division of Valuation of the Interstate Commerce Committee as junior mechanical engineer, where his work dealt with the valuation of the mechanical property of railroads. In April 1916 he became assistant to the superintendent of the Sandusky Cement Co., Bay Ridge, Ohio, where he was employed at the time of his enlistment, July 1917. He was sent to Camp Grant, Ill., for training and in January 1918 went to France as a member of Company C, 21st Engineers.

Sergeant Reilly became an associate-member of the Society in 1916.

AUGUST S. LINDEMANN

August S. Lindemann, secretary and treasurer of the Milwaukee-Waukesha Brewing Co., who died in the early part of 1919 was born in Milwaukee, Wis., in June 1866. He was graduated from the University of Wisconsin in 1885 with the degree of B.M.E. and in 1887 received his master's degree in mechanical engineering.

He served an apprenticeship as machinist with Filer & Stowell and with E. P. Allis & Co., both firms in Milwaukee. He was employed in the drafting room of Flanders & Bottum for one year when he became connected with the Pfister & Vogel Leather Co. as erecting engineer. From 1889 to 1898 he was associated with J. P. Lindemann, first as erecting engineer and later as designer and constructor of new stamping and metal-forming machinery. His next position was

with the Milwaukee-Waukesha Brewing Co., as manager and general superintendent, designing and developing machinery used in bottling works. His advancement was rapid and at the time of his death he held the position of secretary-treasurer of the company.

Mr. Lindemann became a member of the Society in 1913.

WILLIAM TRIMBLE WHEELER

William T. Wheeler, actively connected with the Trinity Engineering Co. and the Diamond Carbonating Co., both of New York City, died on April 27, 1919. Mr. Wheeler was born on August 22, 1862, in Calais, Me., and was educated in the public schools of that city and Pratt Institute, Brooklyn.

For the first twenty years of his business life he was associated with the Equitable Life Insurance Co., in charge of installing the steam, electrical and elevator plants in their buildings, both here and abroad. Later he was connected with the New York Life Insurance Co., as chief engineer of their building in New York City, and still later in charge of the installation of the elevator, electric-light and steam-heating plants for the H. O'Neil Co., New York.

Mr. Wheeler became a member of the Society in 1905.

ELIAS QUEREAU HORTON

Elias Q. Horton, Lieutenant (j.g.), U. S. Naval Reserve Force, died of influenza-pneumonia on March 4, 1919. Lieutenant Horton was born in Ossining, N. Y., on July 28, 1884. He was educated in the public schools of New York City, Stevens Preparatory School and Stevens Institute of Technology, from which he was graduated in 1905 with the degree of M.E.

ELIAS Q. HORTON

Upon graduation he became associated with the Otis Elevator Co., New York, and gained his shop experience in their factory at Yonkers. He was then transferred to the estimating department and in 1908 he was made assistant chief estimator. In 1910 he was made assistant manager in Oklahoma City, in charge of all sales in the state. His advancement was continuous and rapid until, at the time of his enlistment in April 1917, he was in charge of the Washington office of the company.

He enlisted in the Naval Reserve Force and was assigned to active duty as coxswain in Newport, R. I. In June of that year he was sent to Annapolis for special training, and at the termination of the course was commissioned as ensign. He was ordered to duty on the U.S.S. *South Carolina*, where he served as junior watch officer, division officer and communicating officer, respectively. He was then promoted to the rank of lieutenant (j.g.). Shortly before his death he was ordered to the Receiving Ship *Philadelphia*, where he was to have been discharged and to have rejoined the staff of the Otis Elevator Co.

Lieutenant Horton was a member of the Sons of the Colonial Wars, the Sons of the Revolution and of a number of clubs. He became a junior member of the Society in 1912.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by July 15 in order to appear in the August issue.

CHANGES OF POSITION

E. A. HITCHCOCK has recently become connected with the Bailey Meter Company, of Cleveland, Ohio, as vice-president. He will supervise the training of technical graduates for the company's service and sales departments. During the past six years he has been associated with the E. W. Clark and Company Management Corporation, Columbus, Ohio, as advisory consulting and power sales engineer.

G. A. TRUBE, formerly associated with the Westinghouse Air Brake Company, Pittsburgh, Pa., as expert manager, has become connected with Gaston, Williams and Wigmore, of New York.

F. W. TEELE has assumed the duties of general manager of the Mexican Light and Power Company, Mexican Tramways Company and allied interests at Mexico City, Mexico. He was, until recently, associated with the Southern Canada Power Company, Ltd., Montreal, Canada, in the capacity of vice-president and managing director.

CLEVELAND C. SOPER has resigned his position of instructor of machine design, Wentworth Institute, Boston, Mass., and has accepted the position of engineer with the Kent Machine Company, Kent, Ohio.

FREDERICK C. FLADD'S name was inadvertently omitted from the 1919 issue of the Year Book. Mr. Fladd is connected with the E. W. Bliss Company, of Brooklyn, N. Y., in the capacity of traveling and consulting engineer.

ARTHUR E. ANDERSON, formerly chief engineer, The Intermountain Railway, Light and Power Company, Denver, Colo., has assumed the position of general superintendent of The Grand Junction Electric, Gas and Manufacturing Company, and The Grand River Valley Railway Company, Grand Junction, Colo.

A. L. ROBERTS, formerly designing engineer with the Bethlehem Steel Company, has been elected president of The Roberts Company, Philadelphia, consulting and contracting mechanical engineers, and V. F. Signorelli, formerly secretary and treasurer of Southwark Foundry and Machine Company,, has been elected secretary and treasurer. The company has recently been incorporated under the laws of the State of Pennsylvania.

CHARLES E. BURGOON has completed his work with the Air Nitrates Corporation, New York and Muscle Shoals, Ala., and has accepted the position of senior examiner in the cancellation department of the Emergency Fleet Corporation, Philadelphia, Pa.

H. O. C. ISENBERG has severed his connection with the Wright-Martin Aircraft Corporation, New Brunswick, N. J., as factory manager, and has accepted the position of general manager of factories at Ilion, Syracuse and Bridgeport, Conn., of the Remington Typewriter Company.

FRANK D. SHUMATE who has been with the Worthington Pump and Machinery Corporation for a number of years, has assumed the duties of vice-president and sales manager of the Chalmers Pump and Manufacturing Company, which has recently been organized. Mr. Shumate and associates have purchased the entire pumping machinery business of the Canton-Hughes Pump Company, merging it with the Chalmers Manufacturing Company of Lima, Ohio, under the new name of the Chalmers Pump and Manufacturing Company, with general offices and works at Lima.

A. D. STANCLIFF has resigned as superintendent of the Western States Portland Cement Company, Independence, Kan., to accept a similar position with the Cuban Portland Cement Corporation of Havana, Cuba.

FRANK G. WHEELER, until recently connected with the Miehle Printing Press and Manufacturing Company, Chicago, Ill., has become associated with the Chapman Engine Works, Marcellus, Mich.

ANNOUNCEMENTS

C. H. STODDARD has become consulting marine engineer for the Heiner Boiler Company.

RAY B. WHITMAN, formerly engaged in patent work in Chicago, has opened offices in New York, to engage in practice as a patent attorney and engineer, specializing on mechanical and marine inventions. Before entering the patent field, Mr. Whitman was a member of the firm of Whitman and Whitman, mechanical and electrical engineers of Chicago, and during the war was in shipbuilding work with the Emergency Fleet Corporation on the Great Lakes.

HUGH PATTISON has accepted a position with the Westinghouse Electric and Manufacturing Company, New York.

WARREN B. HOOD, since receiving his discharge as Captain in the Ordnance Department, has become connected with the engineering department of the New York Shipbuilding Corporation, Camden, N. J.

P. C. SANGUINETTI has assumed the direction of the research department of L. Bamberger and Company, Newark, N. J. He was affiliated, for several years, with Marwick, Mitchell, Peat and Company, public accountants and industrial engineers, and until recently was engaged in the cost accounting and production engineering field at various plants in the United States and Canada.

LIEUT. COMMANDER JOHN L. MURRIE, U. S. N. R. F., formerly of the New York Edison Company, who has been released from active duty in the government service, and Captain Edward F. McCrossin, U.S.A., announce the formation of a partnership under the firm name of

Murrie and Company, with offices in New York. The firm will conduct a general engineering practice, specializing in engineering, financial and operating reports, valuations and gas and electric rate cases.

WILLIAM F. WALSH has accepted the position of representative of the Galena-Signal Oil Company, with headquarters in Chicago, Ill.

EARLE W. VINNEDGE, First Lieutenant, 7th U. S. Engineers Train, A. E. F., has been discharged from service and has become affiliated with the Worthington Pump and Machinery Corporation, Cincinnati, Ohio, in the capacity of sales engineer.

GEORGE C. LEWIS has assumed the duties of manager of the Philadelphia office of Hersh and Brother. He was until recently assistant chief engineer of the company, at Allentown, Pa.

A. O. HURXTHAL, Captain Ordnance Department, U. S. A., has received his discharge from service and has become associated with The Philadelphia Textile Machinery Company, Philadelphia, Pa.

F. W. SHUMARD, supervisor of the machine and small tools branch of the Motor Transport Corps, Maintenance Division, Washington, D. C., has left the Government service and is now superintendent of Arnold Hellmuth Manufacturing Company, Brooklyn, N. Y.

MAJOR PAUL DOTY, Mem. Am. Soc. M. E., of the general staff, United States Army, came home to St. Paul on May 31 on a brief leave of absence after 21 months in the service. Major Doty was vice-president and general manager of the St. Paul Gas Light Company until September, 1917, when he was assigned to take charge of the utilities at Camp Grant, Ill., and became in effect "city manager" of that military city, directing the operation and maintenance of the large steam heating, electric lighting, water and sewage plants. He was later called to Washington and given general charge of the administration of the utilities of all camps and cantonments. In September, 1918, he was assigned to duty with the general staff.

FRANK H. CLARK has opened an office in New York, as consulting and inspecting engineer, and will handle reports on railway conditions and operations, plans and specifications for railway equipment and for shop and power-plant facilities and inspection of equipment and materials. Mr. Clark was formerly general superintendent of motive power of the B. and O. R. R., Baltimore, Md.

APPOINTMENTS

ERNEST GLEDHILL has been appointed engineer representing the equipment division of the salvage sales section of the Remington Arms Union Metallic Cartridge Company, Bridgeport, Conn.

A. B. RUSSELL, formerly works manager of the Ilion, N. Y. plant of Library Bureau, has been appointed general production manager in charge of the various manufacturing activities of Library Bureau.

WILLIAM KNIGHT, formerly assistant mechanical engineer of the Crocker-Wheeler Company, Ampere, N. J., and during the war a first lieutenant in the Air Service, U. S. A., has recently been appointed technical assistant to the National Advisory Committee for Aeronautics in Europe, with headquarters in Paris, France.

W. C. TYLER, formerly district manager at the New York office of the Poole Engineering and Machine Company, of Baltimore, Md., has been appointed general sales manager in charge of all the selling activities of the country. The general sales office of the company has been removed from Baltimore to New York.

H. R. TROTTER, formerly chief engineer of the S K F Ball Bearing Company, has been appointed chief engineer of the S K F Industries, Inc., New York. The S K F Industries, Inc., has recently been organized to supervise the sales and engineering activities of the Hess-Bright Manufacturing Company, the Atlas Ball Company, the S K F Engineering Laboratories and the S K F Ball Bearing Company.

LIBRARY NOTES AND BOOK REVIEWS

THE AMERICAN MACHINIST SHOP NOTE BOOK. A Collection of Articles Written for the *American Machinist* by Practical Men, Covering a Wide Variety of Machine Shop Activities and Giving the Solution of Problems that have Arisen in Machine Shops the World Over. Compiled by E. A. Suverkrop. First edition. Published by *American Machinist*, McGraw-Hill Book Co., Inc., sole selling agents, New York, 1919. Cloth, 6 x 9 in., 301 pp. 223 illus., $2.

Contents: Drafting and Design, Patterns and Foundry, Forge Shop, Hardening and Tempering, Drilling Machine, Engine Lathe, the Milling Machine, Planer and Shaper, Tool Making, Die and Press Work, Gages, Grinding, Boring, Gearing, Screw Machine, Shop Tools, Appliances and Expedients.

A collection of methods for dealing with difficult or unusual machine-shop jobs, compiled from the periodical mentioned, and classified under the above headings to facilitate ready reference. The articles show methods that have been successful and are suggestive to the machinist faced by similar difficulties.

CUTTING CENTRAL STATION COSTS. Ways by which Central Station Managers, Operating Engineers and Sales Managers are Meeting High Costs. Compiled by S. B. Williams. First edition. Published by *Electrical World*, McGraw-Hill Book Co., Inc., sole selling agents, New York. 1919. Cloth, 6 x 9 in., 322 pp., illus. $2.

The commercial editor of the *Electrical World* has here collected the material contributed to that journal during the last nine months of the war, explaining methods adopted by various central stations. Economies in boiler and generating rooms, line construction, distribution methods, substation practice, commercial practice and administrative plans are discussed.

EFFICIENT RAILWAY OPERATION. By Henry S. Haines. The Macmillan Co., New York, 1919. Cloth, 6 x 9 in., 709 pp., tables, $4.50.

This volume is a description of the progressive development of efficiency in the operation of the railway system in the United States, as compared with similar progress in other countries; for the use of students, railway employees and general readers. Railway operation as distinguished from administration is the subject of the book; matters of finance, rates and labor questions are therefore not included. A bibliography and extensive statistical tables are given in the appendices.

ELECTRICITY AND MAGNETISM FOR ENGINEERS. Part II. Electrostatics and Alternating Currents. By Harold Pender. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 221 pp., 172 illus., $2.

Gives from an engineering point of view, a description of the more important effects commonly described as electrical and magnetic phenomena, and the application of these laws to some of the simpler problems which arise in connection with the generation, transmission and utilization of electric currents. Intended for college instruction.

HANDBOOK FOR HIGHWAY ENGINEERS. Containing Information Ordinarily Used in the Design and Construction of Rural Highways, By Wilson G. Harger and Edmund A. Bonney. Third edition, entirely revised. McGraw-Hill Book Co., New York, 1919. Flexible cloth, 4 x 7 in., 986 pp., illus., tables, 1 map, $4.

This handbook is a compact volume, presenting in convenient form the information ordinarily required in the field and office practice of road design and construction, and is planned to meet the requirements of both experienced and inexperienced road men. In the present edition, approximately 350 pages of new material have been incorporated, covering mountain-road location and design, camp equipment, medical notes, photography, selected soil and gravel treatment of moderate-traffic roads and the recent development of hard-surface roads.

THE NOMON. By Horace G. Deming. Miles and Parris, Champaign, Ill. 1918. General edition, $1.60 postpaid; Chemists edition, $1.60 postpaid; Sugar Technologists' edition, $1.60 postpaid.

The Nomon is a calculating chart, based on a new mathematical principle, that will multiply, divide, square and cube numbers, and extract square and cube roots, to four figures, with an average error of one part in four or five thousand. It is cheap and portable, more accurate in many cases than the slide rule and

quicker than the calculating machine. A particular advantage is the ease with which it solves special formulas of complex types. Any function of a single variable, such as $ax + b$ or $ax^2 + bx + c$, may be multiplied or used as a divisor as if it were a simple variable. An instruction manual accompanies the chart.

TRAINING FOR THE ELECTRIC RAILWAY BUSINESS. Written under the supervision of T. E. Mitten by B. B. Fairchild, Jr. J. B. Lippincott Co., Philadelphia, 1919. Cloth 5 x 8 in., 155 pp., 9 pl., 3 charts, $1.50.

Explains in non-technical language the business side of electric railroading, and gives an insight into the requirements, the opportunities and the training involved in the several departments. The various engineering and transportation problems are taken up and the recruiting and management of the army of laborers needed thoroughly discussed.

THE TURNOVER OF FACTORY LABOR. By Sumner H. Slichter, with an introduction by John R. Commons. D. Appleton & Co., New York, 1919. Cloth, 5 x 8 in., 460 pp., tables, $3.

Contents: General Analysis of the Turnover, the Cost of the Turnover, the Causes of the Turnover and Methods of Reducing the Turnover. The author intends his volume as a comprehensive study of methods of handling men, to supplement existing books on works management. It is founded on personal experience in large industrial plants, visits to factories, talks with employers and working men, schedules and questionnaires. As the study was begun in 1913 and most of the data were collected before the acute situation in 1916, the discussion is from the standpoint in peace times. The book deals with manual laborers generally, except out-of-door seasonal workers.

TRAUTWINE. The Civil Engineer's Pocket-Book. By John C. Trautwine. Revised by John C. Trautwine, Jr., and John C. Trautwine, 3d. Twentieth edition. Trautwine Co., Philadelphia, 1919. Flexible cloth, 4 x 7 in., 1528 pp., illus., tables, $6.

The present volume represents the fourth extensive revision of this well-known work of reference since its original appearance in 1872, and the first since the nineteenth edition as published in 1909. The present edition contains 271 more pages than the preceding one. In its preparation about 400 pages of material have been inserted, relating principally to matters connected with railways, on which subject about 250 pages of new matter have been added. Besides this inclusion of new data, the work has been revised and brought up to date throughout.

MARINE INSURANCE. Its Principles and Practice. By William D. Winter. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 8 in., 433 pp., $3.50.

In this treatise, the writer presents a thorough, simple exposition on marine insurance; suited to the needs of shipping men, merchants and others who require a general knowledge of the subject. Based on a course of lectures given at New York University.

PRACTICAL SHELL FORGING. And the Plastic Deformation of Steel and Its Heat Treatment. By Clifford O. Bower. Longmans, Green & Co., New York, 1919. Cloth, 6 x 10 in., 279 pp., 152 illus., 4 pl., 17 tables, $10.50.

This volume, by an experienced British forge master, is a detailed account of the processes of shell manufacture in which particular attention is given to the laws governing the plastic deformation of steel at high temperatures and the variations in its physical character to be obtained by thermal treatment. It will be useful indirectly, the author hopes, to all persons engaged in the manufacture of hydraulic forgings.

Accessions to the Library

AERONAUTICS IN THE UNITED STATES. By George Owen Squier. *1918.* Gift of author.

AMERICAN ENGINEERING STANDARDS COMMITTEE. Constitution and rules of procedure. *New York.* Gift of Committee.

THE CHEMISTS' POCKET MANUAL. By Richard K. Meade. 3d edit. Purchase.

THE DECLARATION OF THE RIGHTS AND DUTIES OF NATIONS ADOPTED BY THE AMERICAN INSTITUTE OF INTERNATIONAL LAW. By Hon. Elihu Root. *Washington, D. C., 1916.* Gift of Carnegie Endowment for International Peace.

THE DELAMETER IRON WORKS—THE CRADLE OF THE MODERN NAVY. A bit of forgotten Greenwich Village history. By H. F. J. Porter. Gift of the author.

DICTIONNAIRE TECHNIQUE DE L'AVIATION. By John Lycett, Engineer. *Paris, 1918.* Purchase.

DRAWINGS OF OLD PENNSYLVANIA RAILROAD CARS. 26 plates. Gift of Geo. L. Fowler.

EFFICIENCY OF NATURAL GAS AT LOW PRESSURES. Abst. of testimony of Samuel S. Wyer before the Corporation Commission of Oklahoma, Feb. 4, 1919. Printed by Empire Gas & Fuel Co., Kansas City, Mo.

ELECTRIC SMELTING OF DOMESTIC MANGANESE ORES. By H. W. Gillett and C. E. Williams. Gift of the Manchester Steam Users' Association.

ENGINEERING DIRECTORY. No. 65, October, 1918. *London.* Gift from *Engineering.*

ENGINEERING INDEX ANNUAL, THE. 1918. *New York, 1919.*

ENGINEERING SOCIETY OF CHINA, Proceedings and Report of the Council, 1917-18. *Shanghai.* Purchase.

ENGINEMAN'S MANUAL—RICHMOND COMPOUND LOCOMOTIVES. Gift of George F. Fowler.

FEDERAL TAX LAWS AFFECTING INDIVIDUALS, PARTNERSHIPS AND CORPORATIONS. Practical questions and answers. Irving Trust Co. *New York, 1919.* Gift.

FIELD SANITATION. By C. G. Moor and E. A. Cooper. *London, 1918.* Purchase.

FUELS OF WESTERN CANADA AND THEIR EFFICIENT UTILIZATION. Jas. White, Commission of Conservation of Canada. *Ottawa, 1918.* Gift of author.

GASES USED IN WARFARE. By D. D. Berolzheimer. Reprint from Jour. Ind. & Engng. Chem. Vol. 2, No. 3, p. 256. March, 1919. Gift of author.

GAUGES AT A GLANCE. Fourth edition. By Thomas Taylor. *New York and London, 1918.* Purchase.

GOVERNMENT OWNERSHIP OF PUBLIC UTILITIES IN THE UNITED STATES. By Leon Cammen. *New York, 1919.* Gift of author.

HANDBOOK ON EMPLOYMENT MANAGEMENT IN THE SHIPYARD. Special Bulletin, Labor Loss. U. S. Shipping Board Emergency Fleet Corporation. *Philadelphia, 1918.* Gift.

HIGH EXPLOSIVES. By Capt. E. de W. S. Colver. *London, 1918.* Purchase.

A HISTORY OF THE BESSEMER MANUFACTURE IN AMERICA. The Evolution of American Rolling Mills. By Robert W. Hunt. Reprint. Gift of author.

HOURS AND HEALTH OF WOMEN WORKERS. Report of Illinois Industrial Survey. Dec., *1918.* Gift of Louis L. Emmerson.

HUMANIZING INDUSTRY. By Irving Fisher. *1919.* Reprint. Gift of author.

THE HYDROGENATION OF OILS. Catalyzers and catalysis and the generation of hydrogen and oxygen. By Carleton Ellis. Second edition. *New York, 1919.* Purchase.

I FENOMENI ELETTRO-ATOMICI SOTTO L'AZIONE DEL' MAGNETISMO. By Augusto Righi. *Bologna, 1919.* Purchase.

INDUSTRIAL ARTS INDEX. 1918, 3 vols. Purchase.

INFLUENCE OF THE GREAT WAR UPON SHIPPING. By J. Russell Smith. Preliminary Economic Studies of the War, edited by David Kingley. No. 9. *New York, 1919.* Gift.

QUICKSILVER RESOURCES OF CALIFORNIA. Bulletin 78. California State Mining Bureau. *1918.* Purchase.

RAILWAY STATISTICS OF THE UNITED STATES OF AMERICA—FOR YEAR ENDED DEC. 31, 1917. 15th year. By Slason Thompson. Bureau of Railway News and Statistics. *Chicago, Ill.* Gift of Slason Thompson.

THE RECOVERY AND RE-MANUFACTURE OF WASTE PAPER. By James Strachan. *Aberdeen, 1918.* Purchase.

REFRACTORY MATERIALS AS A FIELD FOR RESEARCH. A survey of the scientific aspects of the subject. By Edw. W. Washburn. Reprint from the Jour. of the Amer. Ceramic Soc., vol. 2, no. 1, Jan., *1919.*

THE RELATIVE DESIRABILITY OF SHIPS OPERATING IN FOUR TRADE ROUTES. U. S. Shipping Board, Washington, D. C. Division of Planning and Statistics. *Feb. 28, 1919.* Gift of Henry V. R. Scheel.

RELATIVE MERITS OF CAST-IRON, WROUGHT-IRON AND STEEL PIPE FOR HOUSE DRAINAGE PURPOSES. By Wm. P. Gerhard. *New York, 1918.* Gift of the author.

THE REPRODUCTION OF SOUND. By Henry Seymour. *London.* Purchase.

SHIP CONSTRUCTION AND CALCULATIONS. By George Nicol. *Glasgow and London, 1918.* Purchase.

TAXATION OF FOREST LANDS IN WISCONSIN. THE. By Alfred K. Chittenden, Forest Examiner, and Harry Irion, Forest Service. Sept. 1910. Gift of Geo. F. Fowler.

TRAIN BRAKES AND THE MECHANICAL PRINCIPLES WHICH CONTROL THEIR CONSTRUCTION, WITH SPECIAL REFERENCE TO LOCOMOTIVE BRAKES. The Beals Railway Brake Company. Nov. 15, 1888. Gift of Geo. F. Fowler.

THE TRANSACTIONS OF THE CANADIAN MINING INSTITUTE. Vol. 21. *Montreal, Quebec, 1918.* Purchase.

TUNNEL CONSTRUCTION — AFFIDAVIT OF DANIEL E. MORAN. Equity Suit in United States District Court—Duncan D. McBean, Complainant, vs. The City of New York. vols. I, II, III. Gift of Arthur McMullen.